The AMSAT® Journal

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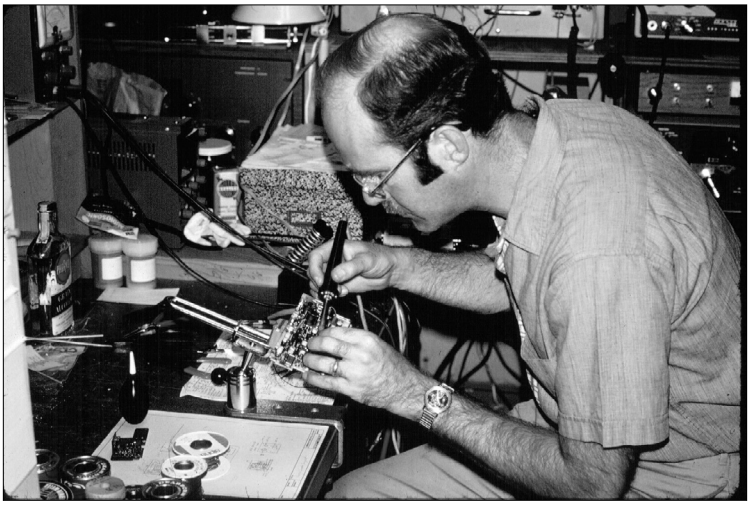
Volume 34, Number 5 **September/October 2011**

To inspire, engage and educate the next generation ...



Venerable AO-7

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AMSAT Announcements

New Journal Editor

Hello members! First let me apologize for the extreme lateness of this issue. I have received very few article submissions over the past several months, which has slowed things considerably. Further, I have been assigned even more responsibility at work (a good thing for me overall) and have less and less time to spend on ham radio and The AMSAT Journal. Thus, I've asked Barry to find someone else to edit the premier publication of AMSAT. Lately I have had even less time to devote to the Journal and feel that I am letting the membership down and potentially damaging AMSAT by releasing issues so late.

I've been the Editor of the Journal now for 8 years. I have enjoyed working on it and I sincerely hope that you have found my efforts valuable. I want to thank all of the authors that have provided articles to the Journal for publication. I also want to thank my co-editors who have helped immensely with the production of the Journal. I greatly appreciate all of their efforts. I especially want to thank Bill Hook, W3QBC, for his yeoman efforts in proofreading each and every issue of the Journal and finding all the little mistakes that creep in. His efforts make the Journal even better.

Please support our new Editor, Doug Loughmiller, W5BL. He will need your contributions just as I have. Please see this month's Apogee View. Again thank you, my apologies for being late and all the best to the new team!

Ed Long, WA4SWJ, Former Editor, The AMSAT Journal

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

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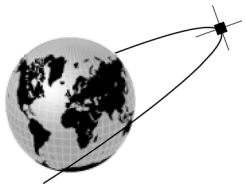
by Barry Baines, WD4ASW • wd4asw@amsat.org



Since my last column there have been a number of developments for AMSAT.

The **AMSAT Space Symposium** was held in San Jose, CA the weekend of November 4th. The Symposium was a very successful event, with excellent presentations of papers submitted to the *Symposium Proceedings* given by a number of the authors. Indeed, the size of the *Proceedings* is very impressive with over 243 pages of materials. Many thanks to Dan Schultz, N8FGZ, for editing the *Proceedings* and to the authors who submitted (and presented) their papers.

Symposium 2011 was held in San Jose, CA to highlight the 50th Anniversary of the launch of OSCAR-1 on December 12, 1961, Amateur Radio's first satellite. Our banquet speaker, Lance Ginner, K6GSJ, gave a very informative and entertaining behind-the-scenes look at the development and launch of the satellite as well as providing details on OSCAR-2 through OSCAR-8. As a key participant in the engineering team of Project OSCAR and later with AMSAT, Lance's perspective was both informative and revealing.

We were also fortunate to have Bob Allison, WB1GCM, of the ARRL Test Lab attend the Symposium as he had on display the OSCAR-1 prototype that his team had refurbished to help commemorate this year's 50th anniversary. Along with having the satellite functioning (demonstrating the CW signal that the original transmitted), Bob also conducted a series of video interviews with key AMSAT personnel as well as Lance Ginner and has posted those interviews on YouTube. The links to those videos are available on the AMSAT and ARRL Web sites.

In accordance with the bylaws of the Radio Amateur Satellite Corporation, the AMSAT Annual Meeting was also conducted. My presentation to the membership at the Annual Meeting is also available on the AMSAT Web site. A link is available on the main page. One announcement that was made at the Annual Meeting is that the 2012 AMSAT Space Symposium will take place in Orlando, FL. We are now in the process of making hotel arrangements and finalizing a date.

The 2011 AMSAT Symposium chairman, Alan Bowker, WA6DNR, and his team (Project OSCAR President Don Ferguson, KD6IRE, and AMSAT member David Hartzell, AF6KD) did a wonderful job making the appropriate arrangements and managing the Symposium during the weekend. We were also fortunate to have Clint Bradford, K6LCS, serve as our Prize Chairman. Clint did a great job recruiting prizes for the AMSAT banquet. We were also fortunate to have the support of Icom, Kenwood and Yaesu who donated major prizes. Finally, my thanks to Martha Saragovitz and Gould Smith, WA4SXM, for their tireless efforts to help guide the Symposium planning and coordinate with Alan's team. I look forward to next year's event in Orlando!

Organizational Changes

We welcome Doug Loughmiller, W5BL, as the new editor of *The AMSAT Journal* effective January 1, 2012. Doug takes the reins from Ed Long, WA4SWJ, who has served as editor for eight years. Ed has done a masterful job of producing the *Journal*, creating a magazine that is well designed and well regarded within the Amateur Radio community. After such a long stint as editor, Ed has decided that it is time for new blood.

Doug, W5BL, is returning to 'active duty' within AMSAT. A former President of AMSAT, Doug brings knowledge of AMSAT and its storied history coupled with a desire to help AMSAT now that he has time to support AMSAT once again. Doug is looking for articles for publication, so feel free to contact him with material for inclusion in the Journal. If you've been active on the satellites, represented AMSAT at hamfests or club meetings, or done some home brewing of satellite equipment, and would like to write an article of your experiences, Doug is anxious to hear from you. Contact him at journal@amsat.org.

We also welcome Mark Hammond, N8MH, as our new Vice President-Educational Relations. The subject of educational outreach was well discussed at Symposium, based upon the paper that I presented as well as other presentations that outlined some of the challenges that AMSAT has experienced in creating a structure for fulfilling our mission component regarding education. Mark has agreed to help AMSAT establish

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AMSAT's Venerable OSCAR-7

by Keith Baker, KB1SF / VA3KSF, kb1sf@amsat.org

(Portions of this article previously appeared as "Spotlight on AMSAT-OSCAR 7" in the November, 2011 edition of *Monitoring Times* Magazine)

In previous columns I've discussed how those interested in receiving (and if properly licensed) actually working through our growing fleet of Amateur Radio satellites could do so with just modest radio equipment. In this edition, I'll turn the spotlight on one of our oldest satellites … one that's been in orbit (and at least semi-operational) for going on 30 years now!

Beginnings

AMSAT-OSCAR 7 (AO-7) was launched November 15, 1974 by a Delta 2310 launcher from Vandenberg Air Force Base near Lompoc, California as a secondary payload along with ITOS-G (NOAA 4) and the Spanish INTASAT satellite. AO-7 was the second satellite in AMSAT's so-

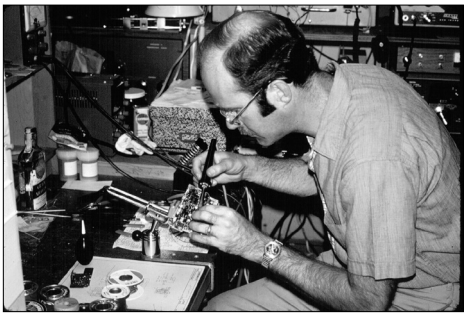

Photo1: AMSAT's satellites are often built in the basements and garages of its experimenters. Here Dick Daniels, W4PUJ, solders components into one of AO-7's electronic modules. (Courtesy: AMSAT)

called "Phase II" satellite series (Phase II-B). That is, unlike their relatively short lifetime predecessor satellites that only carried beacon transmitters, AMSAT's Phase II satellites carried Amateur Radio RF transponders aboard.

When it was launched into a relatively circular, 1444 by 1459 km, 101.7 degree inclination orbit, the octahedral shaped (360 mm high and 424 mm in diameter) satellite weighed in at about 65 pounds. The antenna array consisted of a circularly polarized, canted turnstile VHF/UHF antenna system along with an HF dipole.

Similar to its immediate predecessor (AMSAT-OSCAR 6), AO-7 was built by a multi-national (German, Canadian, United States and Australian) team of radio amateurs under the direction of AMSAT-North America. It carried both a non-inverting Mode A (Mode V/A) and an inverting Mode B (U/V) linear transponder. Telemetry beacons on 10 m and 2 m as well as on 70 cm rounded out the satellite's RF suite. Unfortunately, AO-7's 2304.1 MHz experimental beacon was never activated due to international frequency allocation issues.

Four antennas mounted at 90-degree intervals on the base and two experimental repeater systems provided store-and-forward capability for Morse and teletype messages as it orbited around the world. The Mode-B transponder was designed and built by Professor Dr. Karl Meinzer, DJ4ZC, and Werner Haas, DJ5KQ (SK). The Mode B transponder was the first such transponder using Dr. Meinzer's "HELAPS" (High Efficient Linear Amplification by Parametric Synthesis) techniques … a technology that was painstakingly developed by Dr. Meinzer as part of his Ph.D. dissertation. HELAPS was very effectively used on a number of AMSAT's subsequent satellites.

The two transponders were operated alternately by means of a timer arrangement, but transponder selection and output power control could also be accomplished by ground command. Each of the transponders included a keyed telemetry beacon at the upper edge of the downlink passband to provide housekeeping data as well as a reference marker to assist amateurs in setting their uplink power level. The cross-band design of the two transponders were one of the first such arrangements that permitted amateurs to monitor their own downlink signals so as to help them compensate for changing path loss, transponder loading and Doppler shift.

The Lost is Found

AO-7 was operational for nearly 7 years until a supposed battery failure caused it to cease operation in mid-1981. Then on June 21, 2002, Pat Gowen, G3IOR, stumbled onto something he noted as "remarkable" when hunting for what he called "interlopers" on our 2 m amateur satellite band. During his search, he came across a beacon sending slow, 8 -10 wpm Morse code on 145.973 MHz that was also slowly drifting downward to 145.970 MHz before fading out completely. The beacon sounded VERY familiar to him, but, clearly, it was coming from none of the (then) current satellite fleet. And because of the Doppler shift, the signals were obviously coming from a satellite. But which one?

The beacon peaked at S9 and at times it took on a rough quality, wobbling in frequency then coming back strong and quite stable again. To his surprise, Pat later learned that the satellite he had been listening to was none other than our old AO-7 that had somehow come back to life!

Jan King, W3GEY, AO-7's original Project Manager, later noted that the satellite had a very good set of solar panels and the first Battery Charge Regulator (BCR) AMSAT ever flew. It was also the first spacecraft AMSAT ever built that was capable of actually overcharging the battery. As expected, when the battery failed one or more of the individual battery cells eventually failed "short".

However, what AO-7's experimenters hadn't counted on was what would happen if any one of the failed cells lost its "short" and the battery circuit became "open". Then, the entire power bus would become "unclamped" from ground and all spacecraft loads (including the transponders) could then draw power from the highly efficient solar arrays. At that point, AO-7 might have

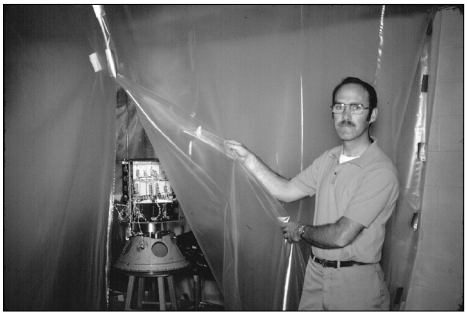

Photo 2: AO-7's final assembly "Clean Room" consisted of stud lumber and plastic sheeting installed in the basement of Dick Daniel's, W4PUJ, home in suburban Washington, DC. Despite such sparse assembly arrangements, AMSAT has never had a satellite rejected by a launch agency because of contamination. (Courtesy: AMSAT)

enough solar power to become a "daytime only" satellite.

Indeed, this is precisely what has since happened and what has miraculously caused AO-7 to come back to life after so many years of being dormant. The only downside to this now "daytime only" satellite is that, every time sunlight hits the spacecraft and it powers up after exiting an eclipse, AO-7

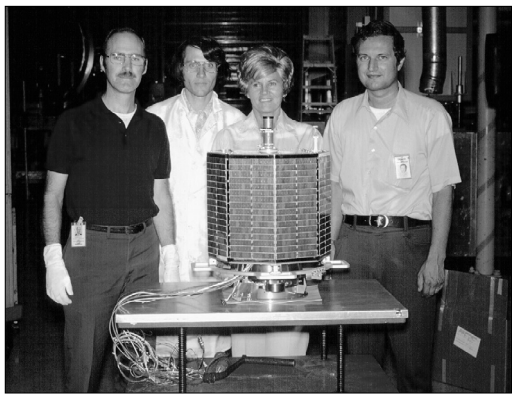

Photo 3: Members of the AO-7 project team pose with the fruits of their labor. From left are Dick Daniels, W4PUJ; Jan King, W3GEY; "hired hand" Marie Marr and AMSAT Founding President Perry Klein, W3PK. (Courtesy: AMSAT)

comes up randomly in either Mode V/A (the old Mode A) or Mode U/V (the old Mode B).

Current Status

Subsequent analysis has revealed that, even after almost 30 years in orbit (and with

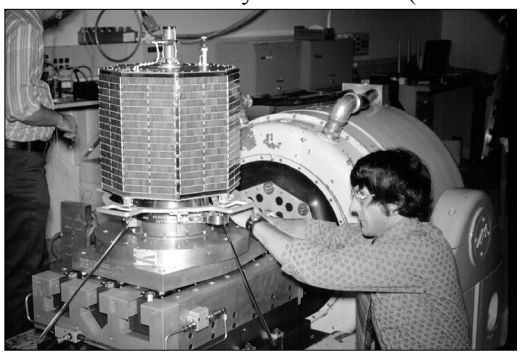

Photo 4: Jan King, W3GEY, prepares the AO-7 satellite for vibration testing. (Courtesy: AMSAT)

the notable exception of the now "open" battery), AO-7 remains in surprisingly good shape. The solar arrays, the BCR, the Instrumentation Switching Regulator, along with the Mode B and Mode A transponders appear to all be working beautifully. What's more, the Morse code telemetry encoder and voltage reference circuitry and other onboard electronics are all still providing useful data to AO-7's ground handlers. And what a testament AO-7 has since become for a satellite that was built (quite literally) by a group of "amateurs" in their basements and garages and launched into Earth orbit almost 30 years ago!

When and Where to Listen

Since it sprang back to life, AO-7 has once again become one of AMSAT's most popular linear (analog) satellites. Indeed, when AO-7 is in full sunlight, it provides surprisingly strong (albeit somewhat "chirpy") downlink signals … even using modest satellite antenna arrays.

However, it takes a bit of patience to determine which mode the satellite is in when it first pops over the horizon. I do this by first setting my downlink frequency in the middle of either passband (at, say 29.450 MHz or 145.950 MHz) and then send a few widely-spaced CW "dits" on the uplink while tuning the frequency of my downlink signal around. Once I hear my own "dits" coming back to me on the downlink, I immediately know which mode the satellite is in, and I then start looking for a contact.

Operating Tips

Because of its relatively high power (2 - 8 watt) downlink transmitters, you should be able to hear very weak signals from AO-7 without needing a lot of uplink power. Remember, this satellite was never intended to be an FM bird! Indeed, I've successfully worked through AO-7 with 5 watts or less to my eggbeater antennas. You may need to increase power if the satellite is at a distance, but be sure to reduce power as the satellite approaches.

Unfortunately, AO-7's mode B uplink is also in the middle of the informal, 70 cm, so-called "weak signal" terrestrial band that was established after AO-7 first went silent. Excessive uplink power may interfere with other services in that band, and may be considered by some to be a spurious, out of band emission.

Also, if you hear your downlink signal start to rapidly change frequency (indicated by a "warbling" sound) this means you are putting too much power into the bird. Reduce power and the situation should correct itself. What's more, as the strongest signals are in the middle of the passband, you will therefore need less power to hear your downlink there. Remember, too, that, voice signals strain the power system on AO-7 the least. So, if you are using CW, please be extra vigilant about the amount of uplink power you are using. Hopefully, with reasonable care from all of us, AO-7 has many years of "semi-operational" life still left in it.

Wrap Up

That's all for this time. In future columns, I'll once again focus on another series of Amateur Radio satellites now in orbit and I'll bring you up to date on other happenings in this fascinating aspect of our radio hobby. See you then!

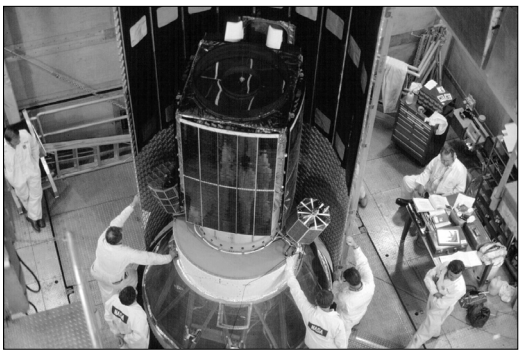

Photo 5: AO-7 is shown here mated to the upper stage of its Delta rocket. AO-7 is shown at the bottom right, next to the much larger main payload. (Courtesy: AMSAT)

Photo 6: AO-7 was successfully launched on November 15, 1974 by a Delta 2310 launcher from Vandenberg Air Force Base near Lompoc, California (Courtesy: NASA)

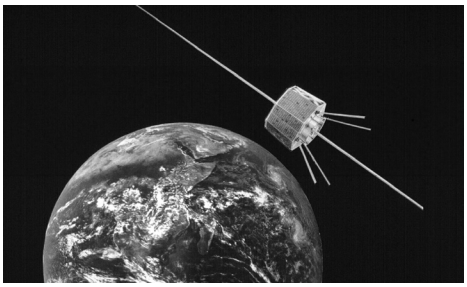

Photo 7: An artist's concept of how AO-7 might appear in orbit today. (Courtesy: AMSAT)

AO-7 FREQUENCY AND MODE DATA			
MODE	UPLINK (MHz)	DOWNLINK (MHz)	BEACONS (MHz)
V/A (Mode A)	145.850 - 145.950	29.400 - 29.500	29.502
U/V (Mode B)	432.125 - 432.175	145.975 - 145.925	145.975
			435.100

More California Amplifier Scrounging: Now it's the Mixer

John M. Franke, WA4WDL, jmfranke@cox.net

Will it ever stop? I hope not! I keep finding more and more uses for parts and sections of California Amplifier MMDS (Multichannel Multipoint Distribution Service) downconverters. I figure now is a good time for S-band receiver experimentation with commercial and military satellites so I will be ready when the next Amateur Radio S-band transponder is orbited. With the increased interest in CubeSats, which have limited surface area for antennas, I am hoping to see S-band activity increase.

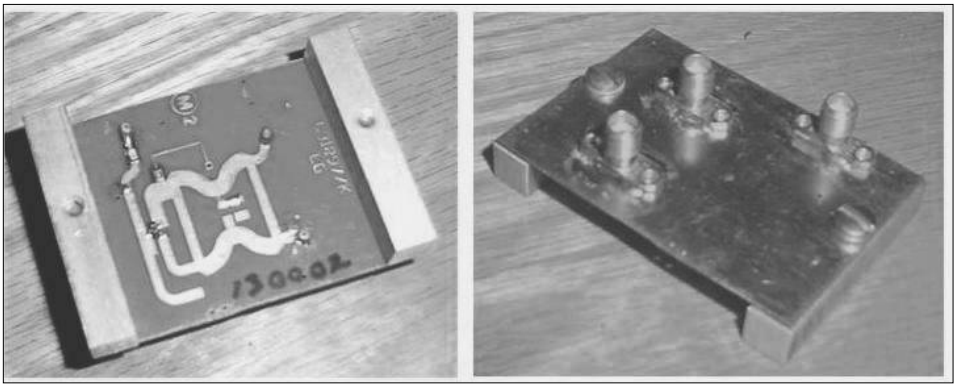

Photo 1A and 1B: Top and bottom view of salvaged mixer.

I had considered bidding on a used Microdyne satellite telemetry receiver covering 2.2 to 2.3 GHz. But, I believe there is fun in building a receiver or converter, particularly when using parts salvaged from MMDS downconverters. And, it is a lot cheaper. One approach I considered was to salvage the mixer and IF amplifier sections together. Another approach was to salvage just the mixer and add an external wideband IF amplifier. Because I had a growing stack of partially salvaged downconverter circuit boards, I decided to try the second approach. Plus, I wanted to experiment with the mixer separately and so salvaging it by itself seemed like the thing to do.

The downconverters use a quadrature hybrid mixer. One drawback with the design is the lack of a convenient point to monitor the current through the mixer diodes. Nor can the individual diodes be tested with a low current ohmmeter. The RF and local oscillator ports (R & L ports respectively) are direct coupled. The output from the mixer (I port) is capacitively coupled. There is no need for a dc return. The chip IF output coupling capacitor for downconverter models 130001 and 130002 measures 1000 pF. Hence the IF low frequency roll off is relatively low, approximately 3 MHz. The upper IF frequency for most MMDS downconverters is 408 MHz. I estimate the actual high frequency roll off for the bare mixer to be over 500 MHz. The bandwidth of the RF input and local oscillator input ports is unknown but is estimated to be useable from 2 to 3 GHz. The best way to find out is to use one. The mixers can also be used for up conversion as well as down conversion, but that is another topic.

I used a hand nibbling tool to cut the mixer section from a model 130002 California Amplifier downconverter printed circuit board. The salvaged board measures 1-5/8" wide and 2-5/16" long. The board could have been much smaller. I added three female SMA chassis mount connectors to the printed circuit board for RF input, local oscillator input and IF output. I used a razor blade to trim the Teflon® insulation around the connector center pins so the connectors would sit flat against the circuit board surface. Using a handheld twist drill, I chamfered the ground plane side of the connector lead holes to provide electrical clearance around the SMA connector pins. The connector flanges were soldered directly to the ground plane. For testing, I mounted the circuit board on two 5/16" square by 1-5/8" long aluminum bars using 6-32 screws through existing holes in the circuit boards, which I enlarged slightly to pass the screws. I used Allen head screws to differentiate between them and the four 4-40 screws I used to mount the mixer on the same plate as the IF amplifier, as will be seen later. The bars elevate the conductor or trace side of the circuit board above my work surface. The mechanical work and soldering took less than a half hour. Top and bottom views of the remounted salvaged mixer are shown in Photos 1A and 1B respectively.

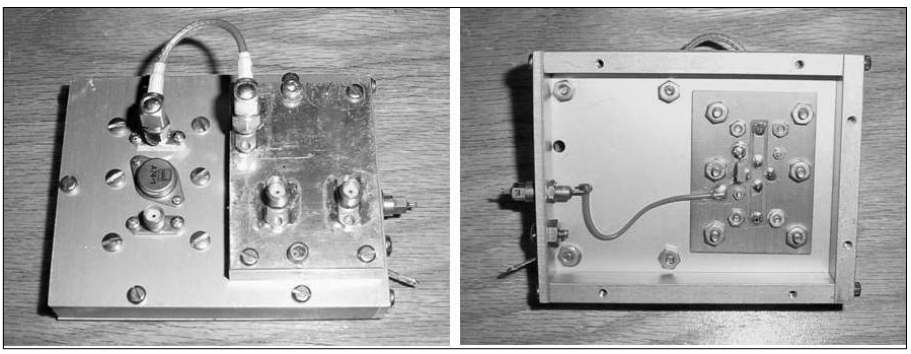

Photo 2A and 2B: Top and bottom view of mixer and IF amplifier.

The mixer worked well during initial testing using a 2.304 GHz source as the local oscillator and a Wavetek model 2002A sweep generator for the RF input signal source. The 2.304 GHz source was a modified California Amplifier downconverter local oscillator. I used a military surplus IP-111/ART-26 30 MHz panadaptor to observe the IF output. A frequency counter allowed me to measure and confirm the beat frequency from less than 2 MHz to over 190 MHz. Swapping the RF and local oscillators input ports had no noticeable effect. Adding a shield to the bottom of the test rig also seemed to have no effect. It is always fascinating to me to see quick results with any microwave circuitry. This is like cut and paste.

Now, I needed more system gain. The easiest place to start was to add an IF amplifier. I selected a Watkins Johnson model WJ-A74-1 MMIC (Monolithic Microwave Integrated Circuit). Another MMIC or discrete component IF amplifier would have worked, I just happened to have a number of the WJ units in my junk box. The WJ-A74-1 MMIC has a gain of 31 dB, a useable bandwidth starting below 5MHz and extending to over 250 MHz, and operates

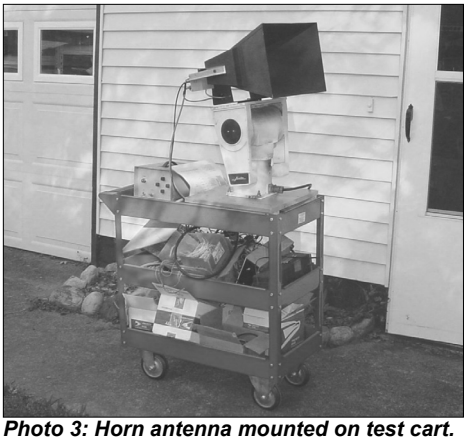

Photo 3: Horn antenna mounted on test cart.

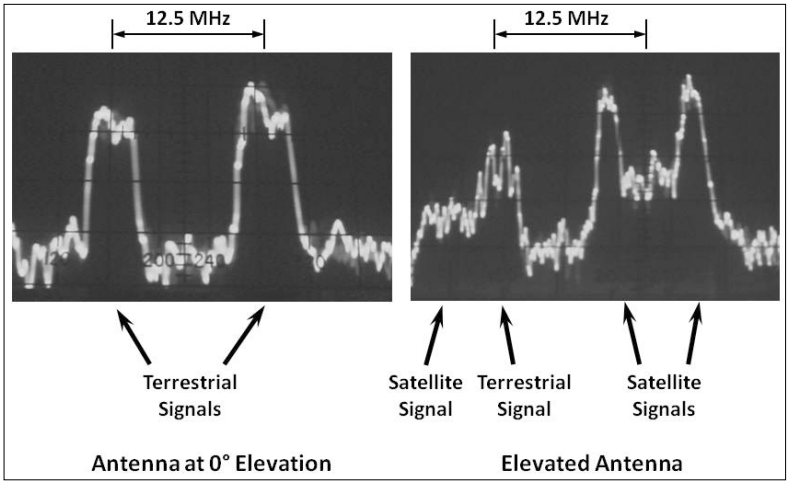

Photo 4: Spectral changes as antenna is elevated.

directly from 15V. No external biasing resistor is needed. The input and output impedances are 50 ohms. The WJ-A74-1 IF amplifier draws 40mA with a supply voltage of 15V (600mW), 32.4mA with a supply voltage of 12V (390mW), and 27mA with a supply voltage of 10V (270mW). For any of the voltages, there is no noticeable change in gain. With a 15V supply, the WJ-A74-1 does get perceptibly warm, but is well within acceptable limits. I am using 10V to reduce power consumption and self heating. By the way, the amplifier input and output lines are dc isolated with internal coupling capacitors. I fabricated a simple printed circuit board for the IF amplifier. I etched the copper from the back side of a 1-1/2" by 2" piece of double sided G-10 printed circuit board stock. Using narrow width drafting tape to mask the areas to be etched, I spray painted the circuit board, removed the tape, and then etched the circuit board in ferric chloride. I added the parts; two SMA connectors, the MMIC amplifier and clamp, and a 0.1 uF dc bypass capacitor for the input power. The finished circuit board is mounted to the underside of the top cover of a homemade enclosure. The aluminum cover serves a dual purpose; providing a ground plane and acting as a heat sink. All of the holes had to go through both the circuit board and the enclosure top cover, so I clamped the two together and drilled all of the holes in one sitting. Even with such a simple circuit, I drilled 18 holes. The SMA connector and MMIC lead holes in just the enclosure cover were later enlarged to provide electrical clearance. I drilled holes in one of the enclosure walls to add a feedthrough capacitor and a ground lug. I sprayed the board with a protective coat of clear lacquer. The module is shown in Photos 2A and 2B. One problem with using a modular approach is the need for larger numbers of connectors and jumper cables.

I attached a short SMA coax jumper cable between the mixer output and the WJ-A74-1 IF amplifier input. Using the 2.304 GHz local oscillator and my Wavetek model 2002A sweep generator as the signal source, I could readily see the pip from a -75 dBm input signal on my panadaptor. The system gain was still low enough that there was no baseline noise on the panadaptor.

The next phase was to find a suitable antenna and a RF preamplifier and then start to look for satellite and other external signals. I had purchased a Polarad model CA-S S-band horn antenna through an online auction several years ago. The antenna frequency range is 2.140 GHz to 4.340 GHz. The horn aperture measures approximately 10.25" by 13.5". The antenna is linearly polarized and can be mounted for receiving vertical or horizontal polarization. I estimate the gain to be +15 dBd. I used a military surplus AS-154N RF preamplifier designed for 1 GHz to 2.6 GHz. The amplifier has a gain of 30 dB and a 5 dB noise figure.

I was eager to try a real off-the-air test signal. One very strong set of signals that originate both terrestrially and from satellites are the SDARS (Satellite Digital Audio Radio Service) signals otherwise known as Sirius Radio and XM Radio. I do not decode the modulation from any of these controlled access commercial sources, but I do use the spectral energy envelope to test receivers and antennas. A frequency chart is provided as Figure 1 (next page). The terrestrial signals are vertically polarized and the satellite signals are LHCP. The relative height of the depicted signals depends on the antenna and the antenna pointing angles. While none of the signals are in the 2.2 to 2.3 GHz band, they are closer to the desired range than are the MMDS signals and at least some of them originate from geostationary orbit satellites, which is definitely far field for antenna testing.

I connected the vertically polarized horn antenna to the preamplifier which was then connected to the modified California Amplifier balanced mixer. I mounted the horn antenna on a tripod purchased at an estate sale and then mounted the RF preamplifier on a bracket on the side of the antenna. I knew I could improve the system performance by minimizing the loss between the antenna and the RF preamplifier. The bracket and antenna surface also serve as a heat sink for the preamplifier and its self contained power supply. Initially, I used the Wavetek model 2002A sweep generator for the local oscillator. Later, I used a 2.278 GHz local oscillator salvaged from a California Amplifier 130001 downconverter. I coupled the local oscillator to the mixer through a 2-4 GHz directional coupler so I could use my homemade 3.0 GHz frequency counter to measure the actual local oscillator frequency. The 3 GHz counter uses the local oscillator prescaler chip from another California Amplifier 130001 downconverter. I decided to use a low band CATV spectrum analyzer instead of the panadaptor to view the IF signals. With the Polarad horn antenna inside the workshop and pointed east, I could see two 4 MHz wide signals centered at 2,326.25 MHz and 2,338.75 MHz, which are from a terrestrial transmitter site.

For testing outdoors, I wanted a more stable antenna mount which I could control remotely. I have an old Javelin model V300PT pan/tilt camera drive I picked up as salvage after the pole that was holding it and a video camera toppled during a hurricane. The camera was crushed, but I was able to recover the pan/tilt drive and fabricate a

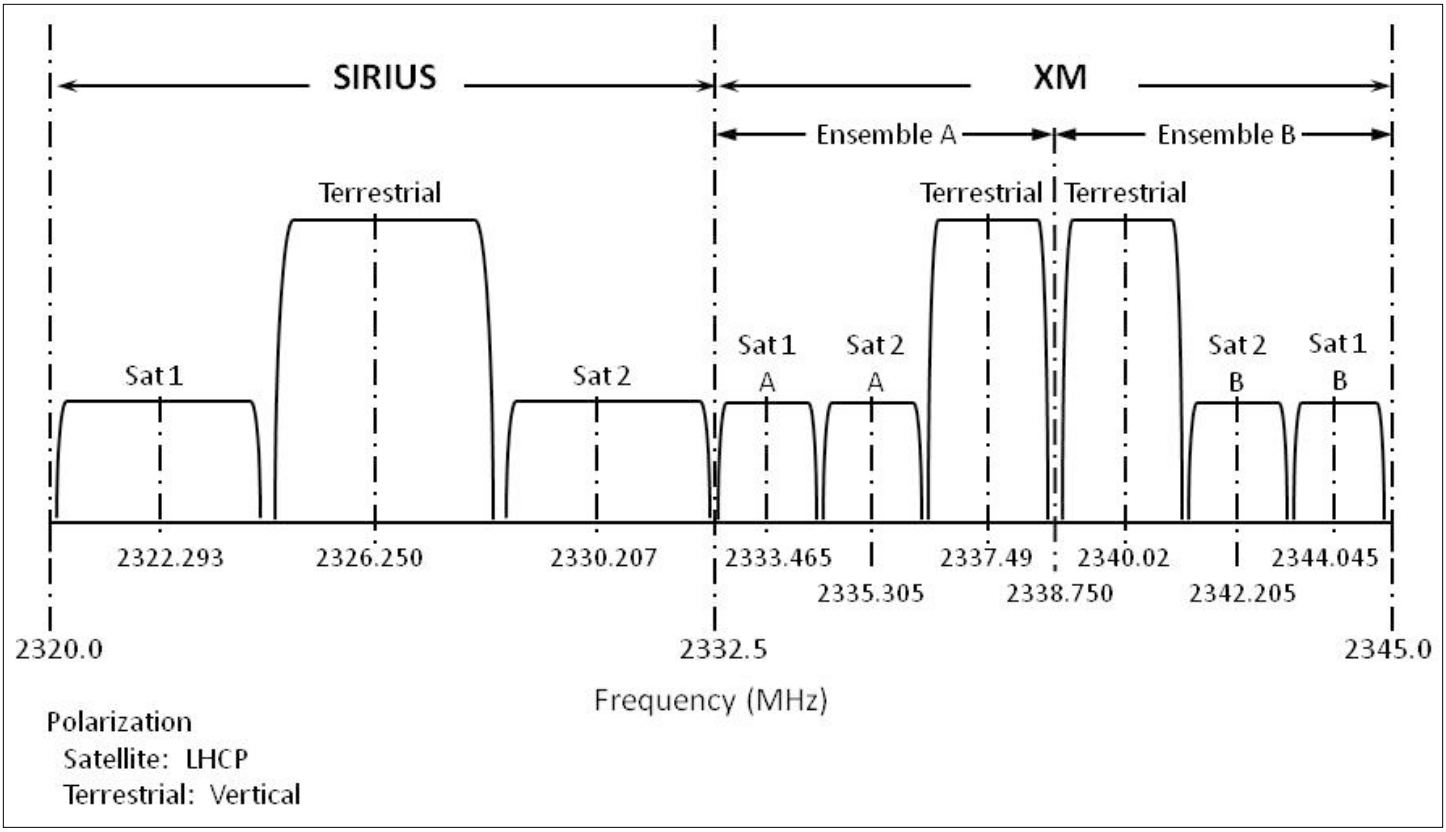

Figure 1: SDARS spectrum.

control box. I mounted the pan/tilt drive on a wheeled tool cart for general testing. The drive is attached to a thick board that sits in the top tray of the cart. Using only the empty tray, made from sheet metal, would allow excessive flexure and wobble. The heavy drive runs off 24Vac and is rated for a maximum load of 35 pounds. The horn antenna is attached to the drive with a single ¼-20 bolt. The horn antenna and test cart is shown in Photo 3.

With the horn antenna now outside, elevated and pointing roughly SSW, I received signals having a narrower bandwidth centered on 2,322.3 MHz (Sat 1), 2,326.25 MHz (Terrestrial), 2,333.47 MHz (Sat 1A), 2,335.3 MHz (Sat 2A), 2,342.2 MHz (Sat 2B), and 2,344.05 MHz (Sat 1B), see Photos 4A and 4B. The horn antenna has a broad enough beamwidth to pick up terrestrial and satellite signals at the same time. Peak signal levels were 18 to 20 dB above the noise. All of the frequency measurements were made by aligning the points of interest to the spectrum analyzer calibration markers and adding or subtracting the local oscillator frequency. I did not expect to see such interesting results so quickly.

My Clarke model 167-J-2 FM telemetry receiver will come into play for receiving 2.2 GHz to 2.3 GHz signals once I build a dedicated 2.1 GHz local oscillator. What is needed next is a lower noise figure preamplifier. Hmm, I wonder how easy it would be to salvage the preamplifier from a California Amplifier downconverter. Microwaves and satellites are truly fun, especially when used MMDS downconverters can be had, at auction, for less than $2.00 each!

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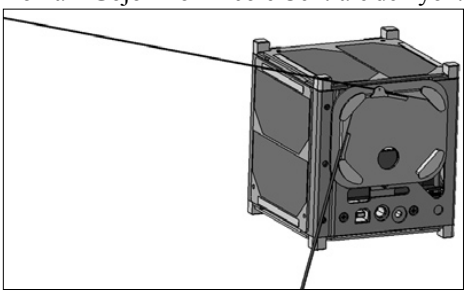
D-Star CubeSat «OUFTI-1» Project of University of Liege, Belgium

by Gaston Bertels, ON4WF, IARU ARSPEX WG Chairman

OUFTI-1 will be the first Belgian student satellite. It is currently being developed at the University of Liège in collaboration with two engineering schools and the University of Louvain. The aim of this educational project is to provide hands-on experience to students in the design, construction and control of complete satellite systems. The various subsystems are thus being developed by students during their M.S. theses.

Team and Schedule for 2011-2012

Five new students joined the team in September: Gilles Bodson, Alain Collette, and Audric Hay from HELMO-Gramme, Alexei Dick from HEPL-INPRES, and Romain Gojon from Ecole Centrale de Lyon.



OUFTI-1

They already gained insight into OUFTI-1 during the first term, in parallel with their classes. They acquired a global technical view of the spacecraft and became familiar with the technologies and equipment involved in their subsystem. They will be working full-time on OUFTI-1 beginning in February.

The first part of the work will be focused on design and development. This will allow the start of manufacturing of the engineering

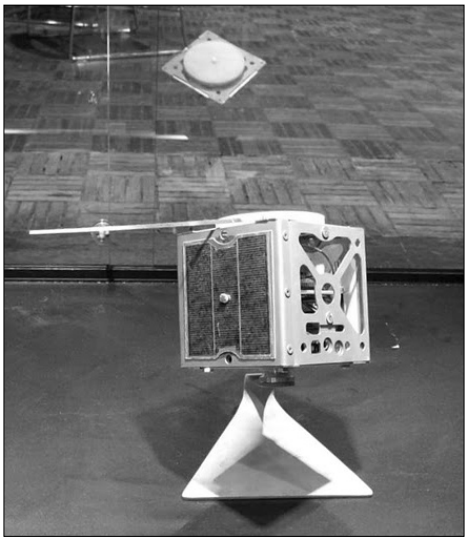
OUFTI-1 construct

model by the end of March. Tests should start about mid-April, first on each subsystem individually and then on interconnected subsystems. The objective is to get a functional and tested engineering model by June. The students will deliver this model along with the necessary documentation to build the flight model.

The flight model will be built during summer, to perform qualification tests by September. These tests will be performed at Centre Spatial de Liège (CSL).

Looking Back on 2010-2011

The components of the Attitude Control System were ordered and received. Two sets of one permanent magnet and four



OUFTI-1 model

hysteresis rods are waiting for integration of engineering and flight models.

The Electrical Power Supply subsystem has its main functionalities implemented and tested. Some secondary functions, such as USB battery charger, are still to be implemented.

The Mechanism subsystem (antenna deployment) was tested at Centre Spatial de Liège (CSL) last June. The tests were performed under vacuum at low (-60°C) and high (+60°C) temperatures. The tests proved the correct functioning of the system, but it was also noticed that the deployment of the antennas could be blocked by a remaining part of the retention wire. This problem is currently being investigated to improve the design and guarantee deployment.

The "processing" part, i.e. (de)coding and (de)modulation, of the Communication subsystem is complete. Regarding the radio frequency part (mainly amplifiers), some tests were performed on the receiving circuit and showed that improvements were needed. The emitting circuit will be designed

OUFTI-1 magnet

by Audric Hay (HELMO-Gramme). He will also integrate and test the whole subsystem.

Most of the On-Board Computer software was coded and tested. This year, Alexei Dick (HEPL-INPRES) will develop a mode dedicated to on-ground tests of the satellite.

The major task of the student in charge of the Thermal Design was to deeply investigate the Thermal Control System of the batteries. Indeed, tests performed in June 2010 showed that the system could not keep batteries above 0°C. The thermal control system was therefore complemented with polymer insulators. The tests performed last June at CSL demonstrated the efficiency of this new solution. Romain Gojon (Ecole Centrale de Lyon) will update the thermal model and perform thermal-vacuum tests on OUFTI-1.

The vibrational behaviour of OUFTI-1 during launch was studied thanks to a detailed finite-element model. Gilles Bodson (HELMO-Gramme) will keep this model up-to-date and perform tests on the engineering model.

The Ground Station hardware is operational at the Montefiore Institute (ULg). The station is regularly used for satellite tracking. Alain Collette (HELMO-Gramme) will develop the Mission Control Software.

Launch

The planning described above aims at a launch towards the end of 2012. Opportunities have been identified and discussions are ongoing with a launch provider. OUFTI-1 will thus not be part of the Vega Maiden Flight (as initially planned). The OUFTI-1 team wishes all the best to the teams of the other CubeSats that will be onboard!

www.oufti.ulg.ac.be

Contact: Amandine.Denis@ulg.ac.be

2012 AMSAT Field Day Competition

by Bruce Paige, KK5DO, kk5do@amsat.org

It's that time of year again; summer and time to plan for Field Day! Each year the American Radio Relay League (ARRL) sponsors Field Day as an emergency preparedness exercise. The event takes place during a 24-hour period on the fourth weekend of June. For 2012 the event takes place during a 27-hour period from 1800 UTC on Saturday June 23, 2012 through 2100 UTC on Sunday June 24, 2012. Those who set up prior to 1800 UTC on June 23 can operate only 24 hours. The Radio Amateur Satellite Corporation (AMSAT) promotes its own version of Field Day for operation via the amateur satellites, held concurrently with the ARRL event.

With the loss of AO-51 and SO-67 Field Day this year is going to be most challenging. If you are considering ONLY the FM voice satellites like AMSAT-OSCAR 16, AMRAD-OSCAR-27 or SaudiSat-Oscar-50 for your AMSAT Field Day focus. Don't, unless you are simply hoping to make one contact for the ARRL rules bonus points. The congestion on FM LEO satellites was so intense in prior years that we must continue to limit their use to one-QSO-per-FM-satellite. This includes the International Space Station. You will be allowed one QSO if the ISS is operating Voice. You will also be allowed one digital QSO with the ISS or any other digital, non-store-and-forward, packet satellite (if operational).

The format for the message exchange on the ISS or other digital packet satellite is an unproto packet to the other station (3-way exchange required) with all the same information as normally exchanged for ARRL Field Day,

e.g.:

W6NWG de KK5DO 2A STX

KK5DO de W6NWG QSL 5A SDG

W6NWG de KK5DO QSL

If you have worked the satellites on Field Day in recent years, you may have noticed a lot of good contacts can be made on some of the less-populated, low-earth-orbit satellites like Fuji-OSCAR 29 (may or may not be operational) and AMSAT-OSCAR 7. During Field Day the transponders come alive like 20 meters on a weekend. The good news is that the transponders on these satellites will support multiple simultaneous contacts. The bad news is that you can't use FM, just low duty-cycle modes like SSB and CW.

The 2012 AMSAT Field Day Rules

The AMSAT Field Day 2012 event is open to all Amateur Radio operators. Amateurs are to use the exchange as specified in ARRL rules for Field Day. The AMSAT competition is to encourage the use of all amateur satellites, both analog and digital. Note that no points will be credited for any contacts beyond the ONE allowed via each single-channel FM satellite. Operators are encouraged not to make any extra contacts via theses satellites (Ex: AO-27 & SO-50). CW contacts and digital contacts are worth three points as outlined below.

1. Analog Transponders

ARRL rules apply, except:

- Each phone, CW, and digital segment ON EACH SATELLITE TRANSPONDER is considered to be a separate band.
- CW and digital (RTTY, PSK-31, etc.) contacts count THREE points each.
- Stations are limited to one (1) completed QSO on any single channel FM satellite. If a satellite has multiple modes such as V/u and L/s modes both turned on, one contact each is allowed. If the PBBS is on - see Pacsats below, ISS (1 phone and 1 digital), Contacts with the ISS crew will count for one contact if they are active. PCSat (I, II, etc.) (1 digital),
- The use of more than one transmitter at the same time on a single satellite transponder is prohibited.

2. Digital Transponders

For the Pacsats (GO-32, etc.) or 'Store and Forward' hamsats, each satellite is considered a separate band. Do not post "CQ" messages. Simply upload ONE greeting message to each satellite and download as many greeting messages as possible from each satellite. The subject of the uploaded file should be posted as Field Day Greetings, addressed to ALL. The purpose of this portion of the competition is to demonstrate digital satellite communications to other Field Day participants and observers. Do not reply to the Field Day Greetings addressed to ALL.

The following uploads and downloads count as three-point digital contacts.

(a) Upload of a satellite Field Day Greetings file (one per satellite).

(b) Download of Satellite Field Day Greetings files posted by other stations. Downloads of non-Field Day files or messages not addressed to ALL are not to be counted for the event. Save DIR listings and message files for later "proof of contact."

Please note AMSAT uploaded messages do not count for QSO points under the ARRL rules.

Satellite digipeat QSO's and APRS short-message contacts are worth three points each, but must be complete verified two-way exchanges. **Remember, only one digipeat contact is allowed for the ISS and other satellites in this mode.**

The use of terrestrial gateway stations or internet gateways (i.e. EchoLink, IRLP, etc.) to uplink/downlink is not allowed.

Sample Satellite Field Day Greetings File:

Greetings from W5MSQ Field Day Satellite station near Katy, Texas, EL-29, with 20 participants, operating class 2A, in the AMSAT-Houston group with the Houston Amateur Television Society and the Houston QRP club. All the best and 73!

Note that the message stated the call, name of the group, operating class, where they were located (the grid square would be helpful) and how many operators were in attendance.

3. Operating Class

Stations operating portable and using emergency power (as per ARRL Field Day rules) are in a separate operating class from those at home connected to commercial power. On the report form simply check off Emergency or Commercial for the Power Source and be sure to specify your ARRL operating class (2A, 1C, etc.).

AND FINALLY...

The Satellite Summary Sheet should be used for submission of the AMSAT Field Day competition and be received by KK5DO (email or postal mail) by 11:59 P.M. CDT, Monday, July 09, 2012. The preferred method for submitting your log is via e-mail to kk5do@amsat.org or kk5do@arrl.net.

You may also use the postal service but give plenty of time for your results to arrive by the submission date. Add photographs or other interesting information that can be used in an article for the *Journal*.

You will receive an email back (within

one or two days) from me when I receive your email submission. If you do not receive a confirmation message, then I have not received your submission. Try sending it again or send it to my other email address.

If mailing your submission, the address is:

Bruce Paige, KK5DO

Director of Awards and Contests

PO Box 310

Alief, TX 77411-0310.

Certificates will be awarded to the first-place emergency power/portable station at the AMSAT General Meeting and Space Symposium in the fall of 2012. Certificates will also be awarded to the second and third place portable/emergency operation in addition to the first-place home station running on emergency power. A station submitting high, award-winning scores will be requested to send in dupe sheets for analog contacts and message listings for digital downloads.

You may have multiple rig difficulties, antenna failures, computer glitches, generator disasters, tropical storms, and there may even be satellite problems, but the goal is to test your ability to operate in an emergency situation. Try different gear. Demonstrate satellite operations to hams that don't even know the HAMSATS exist. Test your equipment. Avoid making more than ONE contact via the FM-only voice HAMSATS or the ISS and enjoy the event!

This form is designed to allow for easy editing in a Word Processor.

AMSAT Satellite Summary Sheet - 2012

Satellite and number of Voice QSO's

AO-27 1 (example)

Satellite and number of CW/RTTY/PSK31 etc. QSO's

AO-07 5 (example)

Satellite and Up/Downloads

UO-11 3 (example)

Score Calculation

Total Voice QSO's	x 1 =
Total CW/RTTY/PSK31 QSO's	x 3 =
Total Up/Downloads	x 3 =
Grand Total	=

Please provide the following information:

Your Field Day Callsign

Your Group Name

ARRL Field Day Classification

ARRL Section

Power Source (Select 1)

Emergency

Commercial

Your name and home call

Home address

Any Comments

The AMSAT Store (see www.amsat.org) is back online! Here is a new AMSAT product. A handsome and functional AMSAT 10' locking carpenter's tape with both inch and metric scales.

Minimum donation: $5

Dick Daniels, W4PUJ - SK
1932 – 2012

By Jan A. King, W3GEY / VK4GEY

One of AMSAT's most important, admired and well loved members, Dick Daniels, W4PUJ (ex WA4DGU), died today, February 14, 2012. He lost his battle with lung cancer, diagnosed only at Christmas time 2011. Dick achieved so much working for AMSAT that it is virtually impossible to enumerate his individual accomplishments. And we cannot overestimate the importance of his sustained support. Dick was many things to us but, among them he was our record keeper, photographic recorder and the de facto AMSAT historian. So, his loss also represents the loss of many memories of the things we did and the places we've gone as an organization, which simply can't be recorded or kept except in a mind. So, our loss is huge! The records of our earlier spacecraft developments, starting with Australis-OSCAR-5 and continuing to present, amount to over 6,000 individual (non-duplicate) 35 mm slides. These have since been digitized. These were all kept and maintained by him. Many of the photos were his own.

Dick was born in Cincinnati, Ohio on May 19, 1932. He received a BBA degree from the University of Cincinnati in Business Management in 1956 and an MBA from the University of Pennsylvania Wharton Graduate School in 1957. He joined NASA HQ in 1961 where he remained until his retirement in 1994. Dick became a licensed radio amateur in 1959. He was involved with the formation of AMSAT in 1970 and served on the AMSAT Board of Directors from 1992 to 2003.

Dick was one of the initial AMSAT members and was Life Member 11. His first major contribution to Amateur Radio was his work to obtain permission from the NASA Administrator (then James Fletcher) and the NOAA Administrator (then Jack Townsend) for the launch of Australis-OSCAR-5. It was Dick who pushed our AMSAT letter proposal for the launch of AO-5 through the NASA and NOAA systems. Dick was also heavily involved in our efforts to license AO-5 with the FCC. That was a much bigger deal back in 1970 than it is today. Few will appreciate the resistance we had within the system from the TIROS project office at NASA/GSFC and what had to be done to overcome it. Few will also remember the support we had from places we didn't expect, but, with Dick's help and all of us pushing – we were in "business" – the "business" of building satellites for free.

Dick became AMSAT-NA's primary mechanical designer and technician, having helped design and then assemble just about every spacecraft structure we launched starting with AMSAT-OSCAR-6. At the beginning of the Phase-3 era it became clear that AMSAT needed to go into the propulsion business if we were going to get to higher orbits and Dick took on the role of chief propulsion expert, in addition to his mechanical technician duties. Dick and I installed the Thiokol solid propellant kick motor into the ill-fated Phase-3A satellite once it arrived in French Guiana and it was Dick, working with MBB who loaded the bi-propellant fuels (UDMH or AZ-50 and N_2O_4) on-board AO-10, AO-13 and AO-40 (all very dangerous compounds). Even though the rocket motor each time was pure German technology, Dick was the one we all trusted to handle the exacting task of propellant loading. He also developed, assembled and tested all of the PFAs (propellant flow assembly) units that controlled the fuel flow and pressurization of each of the propulsion systems. He also contributed significantly to their design details. The utilization of real, high performance propulsion systems on small satellites is still something no small satellite organization other than AMSAT has successfully achieved. Few have even attempted to follow in our footsteps. We've had our difficulties with rocket motors (and what organization that has tried to use them has not?) but, at least AO-13 was perfect. No professional organization has ever done much better than the performance of that propulsion system. And, in large measure, the success of that system can be credited to Dick Daniels. The other P3 satellites, at least had partially successful motor firings, except for Phase-3A which was lost due to a launch vehicle failure, hence we never had a chance to fire our solid rocket motor.

Dick constructed the AO-6 2m/10m repeater (or transponder) designed by Perry Klein, W3PK, and Karl Meinzer, DJ4ZC. He also constructed the follow-on unit flown on AO-7. He assembled major portions of the receiver units forming both the command system and packet communications system developed by Tom Clark, K3IO (ex W3IWI), for the four Microsat spacecraft launched in 1990. Dick assembled so much hardware that if you were to look at each individual sub-assembly that he built or worked on – as they exist in our master photo set – and you viewed each slide for 10 seconds, it would take over an hour to view all of them! That is a lot of space flight hardware.

Dick loved space flight, he loved the challenge represented by the amateur satellite program and he loved working with our many friends around the world. Together we accomplished something that will take years before others reproduce. More importantly, with Dick's huge support we actually created a new industry. Few lives can claim to have done that. The small satellite industry is very alive and well and, as a sector of all space commerce it is now the fastest growing area. If Dick had not made his contributions, AMSAT would have had a very different history but, because of him and others who worked so hard to get things started, AMSAT is at the root of all of today's small satellite technology. This is a fact, not wishful thinking.

Dick also loved nature and the outdoors. We spent many happy times hiking in the mountains of Virginia, using the "famous" Daniels "cabin" as a base camp. We had great times chasing butterflies and watching sea turtles in French Guiana. Dick has a wonderful family and even though AMSAT took a significant fraction of his free time his daughter Kathy and his son Robert are proud of his accomplishments. Like all AMSAT "widows" Jackie supported Dicks "hobby" with enthusiasm and never complained about her time alone when Dick was integrating AMSAT spacecraft on the night shift (sometimes at home and sometimes with me at the AMSAT lab). His family will miss him terribly as he was not just an average father and husband.

continued on page 20 ...

Radio Club of America Honors AMSAT's Tom Clark, K3IO

by Bill Tynan, W3XO, AMSAT Life Member No. 10 and Radio Club of America Fellow

At its annual Awards Banquet held this year at the Texas Motor Speedway near Fort Worth November 19th, the Radio Club of America honored our own Tom Clark, K3IO, by elevating him to the rank of Fellow in that prestigious organization.

Tom was cited for his career with NASA's Goddard Space Center in the field of radio astronomy, particularly his work in long baseline interferometry. His role in serving as AMSAT's President during a particularly stressful period was also mentioned.

The Radio Club of America is the oldest radio club in the World, dating back to 1909. Among its members have numbered such notables as Major Edwin H. Armstrong, the inventor of the superheterodyne circuit, the super-regenerative detector and the system of frequency modulation still used today for police, fire and most other two-way radio communication as well as broadcasting. Other Radio Club of America members included Fred M. Link, an early two-way radio equipment manufacturer, David Sarnoff of RCA and Senator Barry Goldwater, K7UGA.

Next year's Awards Banquet will revert back to its customary venue, the New York Athletic Club in New York City.

Editor's Note: Apologies for the photo quality. The photo was supplied to us in this condition. Tom is at the right.

New Version!

AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP, Vista, Windows 7.

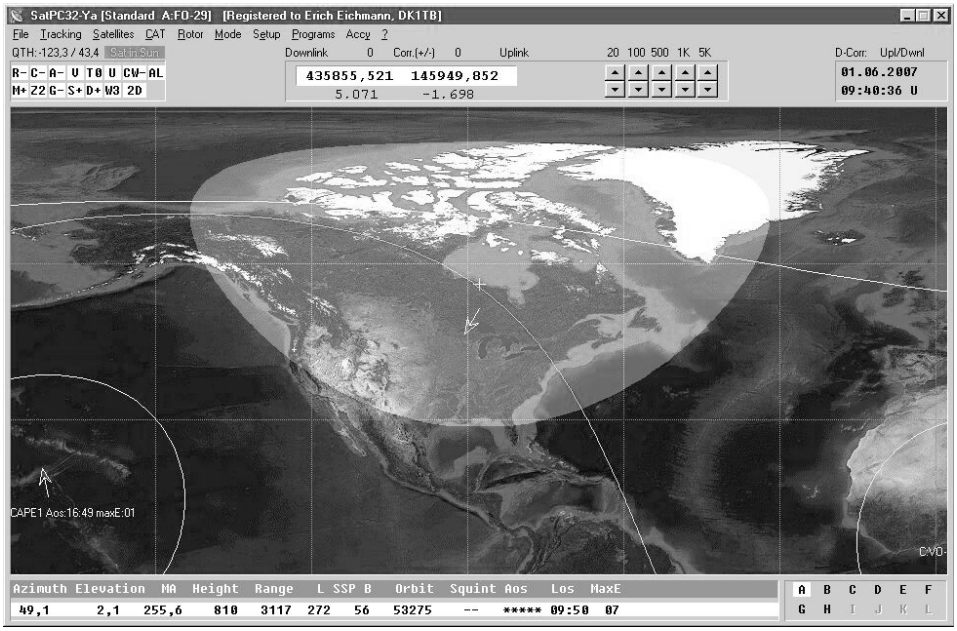
Version 12.8b is compatible with Windows 7 and features enhanced support for tuning multiple radios.

Version 12.8b features:

- SatPC32, SatPC32ISS, Wisat32 and SuM now support rotor control of the M2 RC-2800 rotor system.
- The CAT control functions of SatPC32, SatPC32ISS and Wisat32 have been expanded. The programs now provide CAT control of the new Icom transceiver IC-9100.
- The main windows of SatPC32 and SatPC32ISS have been slightly changed to make them clearer. With window size W3 the world map can be stretched (only SatPC32).
- The accuracy of the rotor positions can now be adjusted for the particular rotor controller. SatPC32 therefore can output the rotor positions with 0, 1 or 2 decimals. Corrections of the antenna positions can automatically be saved. In previous versions that had to be done manually.
- The tool 'DataBackup' has been added. The tool allows users to save the SatPC32 program data via mouse click and to restore them if necessary. After the program has been configured for the user's equipment the settings should be saved with 'DataBackup'. If problems occur later, the program can easily restore the working configuration.
- The rotor interfaces IF-100, FODTrack, RifPC and KCT require the kernel driver IOPort.SYS to be installed. Since it is a 32-bit driver it will not work on 64-bit Windows systems. On such systems the driver can cause error messages.To prevent such messages the driver can now optionally be deactivated.
- SuM now outputs a DDE string with azimuth and elevation, that can be evaluated by client programs. Some demo files show how to program and configure the client.

Minimum Donation is $45 for AMSAT members, $50 for non-members, on CD-ROM.
A demo version may be downloaded from http://www.dk1tb.de/indexeng.htm
A registration password for the demo version may be obtained for a minimum donation of $40 for members and $45 for non-members.
Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



AMSAT *Fox-1* and the NASA ELaNa Program

by Tony Monteiro, AA2TX, aa2tx@amsat.org

Introduction

The CubeSat concept was originally developed by Jordi Puig-Suari at Cal-Poly and Bob Twiggs at Stanford as a way to reduce satellite launch costs making space more accessible to university student projects. This effort has been highly successful. For a US-based launch to LEO, a satellite the size of AO-51 would cost over $1M whereas a CubeSat launch can be had for around $125k. But, while that is much less expensive, $125k is still a substantial sum for a university or AMSAT to raise for the launch.

To help stimulate interest in CubeSats as part of their Science, Technology Engineering and Math (STEM) education goals, NASA developed the "Educational Launch of NanoSat" (ELaNa) program. This program provides a free CubeSat launch as an auxiliary payload on a NASA mission. The first ELaNa request for proposal (RFP) was issued in February of 2010. Since this was aimed at promoting STEM education, only accredited educational institutions were eligible to apply. Three CubeSats were selected and launched in March of 2011 on the NASA Glory mission. Unfortunately, the launch vehicle failed and all of the satellites were lost. Nonetheless, NASA was pleased by the interest that was generated and has expanded the program. The most recent RFP, issued in August of 2011, included new opportunities for US-based, non-profit organizations - AMSAT was now eligible!

AMSAT is of course always looking for a free launch, so an effort was initiated to make the required adjustments to our Fox-1 program to make it consistent with NASA requirements and to develop our proposal. The key issue to qualify is to explain how the project helps NASA meet their education and science goals. These are identified and described in the NASA Strategic Plan [1] and the NASA Education Strategic Coordination Framework [2].

The complete AMSAT's Fox-1 ELaNa proposal included very detailed technical and project information and was a total of 159 pages long. That would be too long to reproduce here, but key highlights including the abstract and main body of the proposal are presented in the following sections.

To inspire, engage and educate the next generation ...

The front cover photo shows 5th grade students participating in a hands-on STEM learning experience offered through their school's gifted and talented program. These elementary school students learned about space communications first hand, as they accessed the AMSAT AO-51 satellite. Though AO-51 is now silent, Fox-1 will ensure continued availability of these learning opportunities.

Fox-1 ELaNa Proposal Abstract

AMSAT is a non-profit, research and education organization. Since its founding in 1969, it has been a pioneer in the development and applications of small and micro satellites. AMSAT projects are funded through donations and passionate volunteers do all of the technical work. While most of our volunteers are highly experienced industry veterans or retirees, AMSAT welcomes contributors of all ages and technical abilities and provides training as needed. With over 3,000 members, AMSAT is well represented throughout the ranks of industry, NASA and the university satellite community. Many AMSAT members have been technical advisors on university CubeSat projects.

AMSAT Fox-1 is a 1-Unit CubeSat and the primary focus of the project is education. The satellite will host a two-way FM communications transponder and an experiment payload. The communications package is specifically designed to be easy-to-use requiring only a simple walkie-talkie style radio combined with a small hand-held antenna. Using Amateur Radio frequencies, it will be open and available to the general public. This simple, low-cost on-orbit capability facilitates a wide spectrum of STEM educational opportunities from inspiring young minds and engaging secondary school students to educating teachers and university students.

In the classroom, having an accessible on-orbit asset will allow schools, teachers and students to participate in space technology with a hands-on experiential learning approach. This approach can help make difficult STEM concepts far more interesting and easier to grasp. AMSAT aims to make STEM education fun.

On the informal side, Fox-1 will provide a technology stepping stone that is easily accessible to the average citizen, requiring only an Amateur Radio license to participate. This can generate interest in STEM topics through a hobby activity and may even lead to active participation in satellite technical advancement. Fox-1 will also enable informal groups with educational goals, such as youth scouting organizations, to help inspire their members to embrace STEM through participatory activities using the satellite. This promotes technology and space literacy among the general public.

In addition to the communications package,

Fox-1 will host an experiment payload developed by university students. AMSAT is sponsoring this development as a capstone project at Penn State University for the 2011-2012 academic year. Senior engineering students are developing an attitude determination experiment for graduation credit with mentoring and guidance provided by AMSAT. In addition to the hands-on, real-world experience provided to the students, the experiment data will be valuable in planning future satellite projects. All of the experiment and satellite telemetry data will be collected and stored on our Internet server. This data will be made publicly available for use in the classroom by educators and shared with the general CubeSat community.

The Fox-1 project has an educational focus and we conducted a non-competitive merit review. Our review panel members included academic and industry experts who were not on the Fox-1 development team. The merit review panel concluded that the project "meets NASA needs and goes beyond." The merit review team also offered suggestions for improving our education message and these have been incorporated in the Fox-1 project.

We conducted a non-competitive feasibility review. Our review panel members included academic and industry experts who were not on the Fox-1 development team. The feasibility review committee concluded that there was "a very high probability of success" and noted that the AMSAT team "well exceeded typical other CubeSat teams in depth and breadth of skill and experience." The feasibility review team offered suggestions for improving our development process and these have been incorporated in the Fox-1 project.

Fox-1 ELaNa Proposal Body

1 Introduction

1.1 Eligibility

AMSAT, The Radio Amateur Satellite Corporation, was incorporated in 1969 in Washington D.C. It is a non-profit 501(c)(3) research and education organization listed in IRS Publication 78. AMSAT has over 3,000 members.

1.2 Mission Overview

AMSAT volunteers and undergraduate university students are developing the Fox-1 CubeSat. The primary focus of this project is to support STEM education. Fox-1 will host a two-way FM communications transponder and an experiment payload. The communications package will be specifically designed to be easy-to-use requiring only a simple walkie-talkie style radio combined with a small hand-held antenna. Using Amateur Radio frequencies, it will be open for use by the general public. This capability will facilitate a wide spectrum of STEM educational opportunities from inspiring young minds and engaging K-12 pupils to educating teachers and university students. Collaboration with ARRL, The National Association for Amateur Radio will result in educator training seminars that will include using Fox-1 in classroom activities.

In addition to the communications package, Fox-1 will host an experiment payload. AMSAT is sponsoring a capstone project at Penn State University for the 2011-2012 academic year. Senior engineering students will be participating for graduation credit with mentoring and guidance provided by AMSAT volunteers. The project will involve designing and constructing an attitude experiment based on a 3-axis, micro-electro-mechanical gyroscope. The experiment data will measure the performance of the satellite's magnetic stabilization system. While the primary focus of the experiment payload is to provide a hands-on, real-world educational experience for the students, the experiment data will be valuable in planning future CubeSat projects.

1.3 CubeSat Project Details Table

AMSAT is collaborating with ARRL, The National Association for Amateur Radio. ARRL will be incorporating Fox-1 into their professional development seminars for educators. A letter of support from ARRL and a copy of the Teacher Institute program brochure are included in APPENDIX 2.

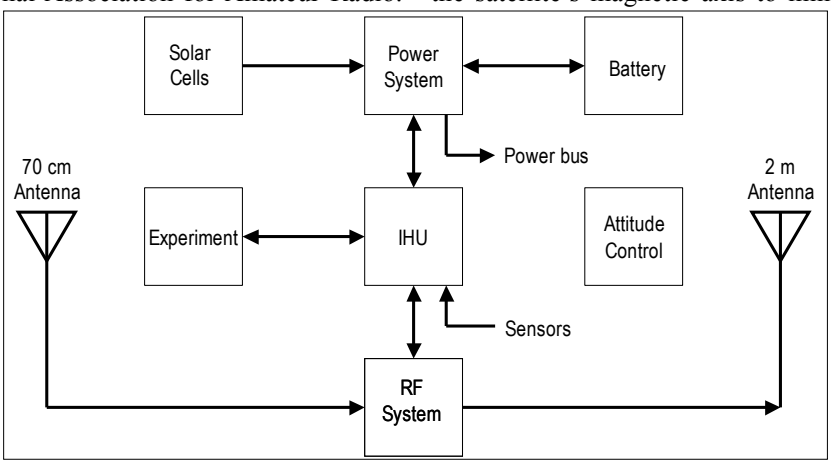
CubeSat Project Details

Focus Area	Student Involvement	NASA Funding		Sponsor	Proposal Collaboration	
		Yes or No	Organization		Yes or No	International Yes or No
Education	Yes	No		AMSAT	Yes	No

2 Fox-1 Spacecraft Description

Fox-1 is a 1U CubeSat. It will be designed and tested to be fully compliant with the Launch Services requirements as described in "Launch Services Program, Program Level Poly Picosatellite Orbital Deployer (P-POD) and CubeSat Requirements Document (LSP-Req-317.01)."

The major subsystems of the Fox-1 satellite include the attitude control system, the power system, an internal housekeeping unit (IHU,) the radio (RF) system and the experiment payload as shown in the figure above. There are six solar panels with one on each face of the CubeSat. The power system uses the power generated by the solar panels to drive the power bus and charge the battery. In eclipse, the power needed to run the satellite comes from the stored energy in the battery. The internal housekeeping unit (IHU) is the brains of the satellite and is based on an ultra-low-power microcontroller. The RF system includes a FM receiver, a FM transmitter and the necessary logic to operate either under control of the IHU or as an automatic FM repeater. The satellite uses passive magnetic stabilization and a photon motor to spin the satellite for thermal considerations. The antennas are monopoles aligned with the satellite's magnetic axis to minimize



CubeSat Mission Parameters								
Mission Name	Mass (kg)	Cube Size	Desired Orbit		Acceptable Orbit Range (minimum)	325 km @ 51.6 degree incl. Acceptable? Yes or No	Readiness Date	Desired Mission Life
Fox-1	1.33	1U	Altitude	650 km	600 km apogee	No	April 2013	10 Years
			Inclination	98.2 deg.	40 deg			

spin-modulation. The experiment payload, being developed by students at Penn State, will include a 3-axis micro-electro-mechanical gyroscope and a microcontroller to calculate the satellite spin rate, direction and off-axis "wobble." This will measure the performance of the attitude stabilization system. Project technical documents are included in APPENDIX 3.

3 Project Organization and People

AMSAT engineering is staffed completely by passionate volunteers and is organized as project teams. Each project has a project leader who is responsible for the overall success of the project including the planning, execution, monitoring, control, completion and budget.

The project work and activities are structured by function or subsystem. A self-directed individual or team is responsible for each of these functional parts of the project. There is no official hierarchy or management within a functional team. AMSAT relies on outstanding informal leaders who have demonstrated superior technical and influence skills to provide guidance to their functional team as well as the entire project. This structure has been used on previous satellite projects and works very well for our distributed volunteer teams.

AMSAT has a university program manager who is responsible for representing AMSAT on the experiment team. The experiment team is staffed with six undergraduate students and a faculty member from Penn State. There is also an AMSAT technical mentor on the team to provide technical assistance.

In addition to the Penn State students, two undergraduate students are working on Fox-1 as AMSAT volunteers. AMSAT recognizes that school is their top priority and welcomes their participation.

The current list of AMSAT and Penn State team members is provided in the Project Plan in APPENDIX 3. Resumes for key AMSAT team members are provided in APPENDIX 1.

4 Engineering Process

Fox-1 follows the AMSAT engineering process. This documented process describes a project lifecycle model and includes Concept, Design, Implementation & Test, and Operations & Maintenance phases. Both formal and informal reviews are used within the phases to maintain system consistency, detect errors as early as possible and to facilitate a clear understanding of the project status. A copy of the AMSAT engineering process is included in APPENDIX 3.

5 Risks and Mitigation

The following areas have been identified as the major project risks and the means of mitigation.

5.1 Volunteer Staff - High Risk

AMSAT's engineering team is all volunteers. Unforeseen family and day-job related events can and have caused loss of volunteer time availability. AMSAT has no capacity to hire replacements. This is the major schedule risk. To mitigate this risk, AMSAT:

- Makes an upfront attempt to staff each functional area with more than one volunteer
- Constantly recruits new volunteers
- Looks to our "bench" of past volunteers for short term assignments if needed
- Includes 3 months of contingency time in the development schedule

5.2 Space Radiation - Medium Risk

The Fox-1 satellite has a target mission lifetime of 5 years in orbit. The target orbit is sun-synchronous at 650 km altitude, which will cause substantially higher radiation exposure than an ISS orbit. AMSAT cannot afford to use Rad-Hard components and COTS components are generally sensitive to radiation. To mitigate this major technical risk, AMSAT will:

- Include a team member who assigned to research radiation
- Model the radiation exposure
- Test key components for radiation sensitivity
- Design the electronics systems for fault tolerance
- Use additional radiation shielding to protect key components.

5.3 New, High Performance Components - Low Risk

Several new high-performance components are recently available that have considerable benefits for use in the Fox-1 satellite. Since they are new, team members have no experience using these components and are unfamiliar with their limitations, especially undocumented or unspecified behaviors. These include components such as a high-efficiency RF power amplifier, an ultra low power microcontroller and a solar panel maximum power point tracker. Since these risks can be reasonably controlled, they pose a low risk level after mitigation but remain as the second source of technical risk. To mitigate these risks, AMSAT plans to:

- Prototype specific circuits and test them in laboratory settings
- Test using manufacturers evaluation cards where possible
- Prove-in new components before design-in to the satellite

5.4 Penn State Student Developers - Low Risk

The experiment card for the Fox-1 satellite is being designed by undergraduate engineering students. These students have limited technical experience. They are also expected to graduate in May 2012 and cannot be counted on after that to work on the project. Since the key NASA benefit from student involvement is training, that benefit is not at risk if the students don't finish the experiment card by graduation. In addition, the primary mission of the satellite will operate without the experiment card. However, AMSAT would not be able to obtain our desired experiment data. To mitigate this low technical risk, AMSAT has:

- An AMSAT program advisor to track progress of the student team
- Provided a technical mentor to the students
- A contingency to have AMSAT volunteers complete the experiment

6 Project Status and Timeline

The initial technical and operational investigations of the AMSAT Fox satellite program were kicked off in October 2010. A Concept Review was held in April 2011 to review the results of these investigations. After further investigations, the program strategy was refined and endorsed by the AMSAT board of directors in July 2011. Fox-1 represents the first project planned within a new series of AMSAT CubeSats.

The project progress so far includes:

- Fox-1 project defined - July 2011
- Concept of Operations (ConOps) - Sept 2011
- System Requirements Spec (SRS) - Oct 2011
- Experiment Payload Specification - Nov 2011
- Project Plan draft - completion expected Dec 2011

A second Concept Review was held in October 2011 to review the proposed Fox-1 satellite bus architecture and design. As of November 2011, two subsystems had been prototyped and tested to address technical risk areas. These include the RF power amplifier and the IHU microcontroller.

Key milestone dates for the remaining development work are as follows:

- Preliminary Design Review (PDR) - March 2012
- First complete engineering prototype - July 2012
- Critical Design Review (CDR) - August 2012
- Flight model ready for test - November 2012
- Launch Readiness Review - January 2013
- Launch Target - 2nd half of 2013

Note that the launch target date includes a 3-month contingency interval to mitigate schedule risk.

7 Project Funding

7.1 Indirect Costs

AMSAT engineering resources are expected to be needed for the project. These do not represent direct project costs but are already included in the overall AMSAT engineering budget.

7.2 Direct Costs

Total component and non-recurring engineering (NRE) costs are estimated at $38,500. Other direct expenses for the project such as travel, meetings, shipping and supplies are estimated at $25,000. The total of the direct project costs is estimated at $63,500. In 2011, approximately $1,500 will be spent on the project leaving $62,000 needed for 2012.

AMSAT has committed to funding the complete cost of the project including the flight satellite and a complete flight spare unit. In addition, the AMSAT budget includes a launch contingency reserve in the event of a requirement to reimburse NASA. Please see the AMSAT funding commitment letter in APPENDIX 2.

8 CubeSat Mission Parameters Table (see previous page)

While AMSAT has indicated a 650 km, sun synchronous orbit as our target, the satellite design will accommodate a wide range of orbit altitudes and inclinations. The major consideration is the desire for at least 10 years in orbit.

Photo used courtesy of Make Magazine

9 Benefits to NASA

The AMSAT Fox-1 project addresses a broad spectrum of involvement identified in the NASA Education Strategic Coordination Framework. This includes inspiring youth and the general public via outreach activities to formal education of university students and professional educators.

9.1 Education Goal: Engaging Americans in NASA's Mission

"NASA will engage students, educators, families, the general public, and all Agency stakeholders to increase Americans' science and technology literacy."

Fox-1 will be a publicly available on-orbit asset designed to be easy-to-use, requiring only an Amateur Radio license to participate. This technology stepping-stone will help generate interest in STEM topics through hobby activities and will lead to active participation in technical advancement.

Fox-1 will enable groups, such as youth scouting organizations and Amateur Radio clubs, to promote informal STEM education through activities using the satellite. It offers opportunities for self-learning and improved technology literacy to interested Americans.

Shown in the photo above is Diana Eng, a well-known fashion designer, demonstrating a collapsible fabric antenna that she created to communicate through the AMSAT AO-51 satellite. Her article about this project appeared in Make Magazine, which targets a wide audience and promotes technology literacy. Though AO-51 is now experiencing battery problems, Fox-1 will ensure continued availability of these opportunities for public engagement.

9.2 Education Goal: Attracting and retaining students in STEM disciplines

"NASA will focus on engaging and retaining students in STEM education programs to encourage their pursuit of educational disciplines critical to NASA's future engineering, scientific, and technical missions."

In the classroom, Fox-1 will allow schools, teachers and students to actively participate in space technology with a unique hands-on experiential learning approach that includes communicating through a satellite in orbit. And, while AMSAT encourages everyone to obtain an Amateur Radio license, the students

do not have to have one to be involved. All that is needed is for a licensed teacher or classroom volunteer to be present.

The smiles on the 7th grade students in the photo on the previous page (lower) belie the fact that they are actively engaged in a STEM activity at their school and learning about satellites. The recent AMSAT ARISSat-1 satellite enabled this activity and shows how the hands-on approach can help make difficult STEM concepts far more interesting and actually fun! ARISSat-1 has de-orbited but all of the satellite telemetry data was collected and stored on an AMSAT Internet server and is openly available for use in the classroom. The Fox-1 project will assure that this capability will be continued and will include free telemetry decoding and display software.

A letter of support from the Clay Center for Science and Technology at the Dexter School and Southfield School endorsing AMSAT satellites for their educational value is included in Appendix-2.

9.3 NASA Education Outcome 2 - Professional Development

"Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty."

AMSAT is collaborating with ARRL, The National Association for Amateur Radio, to insure that timely and accurate information about Fox-1 is included in their professional development courses for educators. Each summer, ARRL offers multiple sessions of the Teachers Institute on Wireless Technology, a 4-day expenses paid professional development seminar. The Teachers Institute has provided educators from elementary school to the university level with tools and strategies to introduce basic electronics, radio science, space technology and satellite communications in their classrooms (at left). The TI-2 seminar, Space in the Classroom, focuses on space and satellite communications. Graduate credits are available through these seminars that can be used to satisfy professional growth requirements needed to maintain teaching credentials. A current program brochure and a letter of support for the Fox-1 project from ARRL are included in APPENDIX 2.

9.4 Education Goal: Strengthening NASA and the Nation's future workforce

"NASA will continue contributing to the development of the Nation's science, technology, engineering, and mathematics workforce of the future through a diverse portfolio of education initiatives that target America's students at all levels"

Over the past several years, AMSAT volunteers have participated in student projects as mentors and advisors at Cornell, SUNY, Auburn, the University of Arizona and the College of New Jersey. These projects have provided undergraduate and post-graduate engineering students with exposure to spacecraft systems design and development.

Building on these successes, AMSAT is sponsoring a capstone project at Penn State University for the 2011-2012 academic year. AMSAT is providing funding, mentoring and technical guidance for the students. Senior engineering students will be developing the experiment payload for Fox-1 for graduation credits. The thrill of knowing that your senior project will be going into orbit is a powerful and exciting motivator for the students.

10 Merit Review

The AMSAT Fox-1 team held a merit review. The review was conducted as an on-line, multimedia teleconference with key members of the Fox-1 team and a review panel of academic and industry experts.

- What was the merit review process?

The AMSAT team presented a set of Power Point slides that included an overview of the Fox-1 mission. Since the focus of Fox-1 is education, we also presented a review of the NASA Education Strategic Coordination Framework including the NASA Education Implementation Framework. The aspects of the Fox-1 project that address the NASA education goals and outcomes were highlighted. The review panel was then asked for their comments, suggestions and an overall assessment of the merits of the Fox-1 project.

- Was the merit review competitive or non-competitive?

The merit review was non-competitive.

- What were the qualifications of the merit review committee members?

The merit review panel included the following members (alphabetical order):

1. Mr. David Hinkley is the Project Leader, Mechanics Research Office of The Aerospace Corporation.
2. Dr. Allen Katz is a Professor of Engineering Science, College of New Jersey and President of Linearizer Technology, Inc. (LTI.)
3. Mr. Jan King is a distinguished space industry veteran with more than 40 years of experience including the development of 12 large and 17 small spacecraft and one launch vehicle.
4. Dr. Robert McGwier is the Director of Research, Hume Center for National Security and Technology and a Research Professor, Department of Electrical and Computer Engineering, Virginia Tech.

Please see APPENDIX 1 for resumes of the members of the review panel.

- What factors did the merit review use to assess merit?

The panel was asked to assess the educational aspects of the Fox-1 project that were identified as supporting the goals and outcomes identified in the NASA Education Strategic Coordination Framework.

- What was the outcome of the merit review?

The merit review panel determined that the project "nailed" the education goals and that the project "meets NASA needs and goes beyond." A panel member commented that AMSAT has a history of space education that is "demonstrated better than just about any other organization." The review panel suggested that we should mention our past successes especially the ARISSat-1 and AO-51 satellites.

Another suggestion was that we should point out that in the classroom, only a teacher or an outside volunteer needs to have an Amateur Radio license to allow the students to make use of the satellite. They also recommended that we highlight that all of our telemetry and experiment data will be openly available on our server and has educational value for classroom use.

- How did the Respondent respond to and/or address the findings of the merit review?

We will update our Public Relations plan to include mention of the additional educational benefits suggested by the review panel.

11 Feasibility Review

The AMSAT Fox-1 team held a feasibility review. The review was conducted as an on-line, multimedia teleconference with key members of the Fox-1 team and a review panel of academic and industry experts.

- What was the feasibility review process?

The AMSAT team presented a set of Power Point slides that provided key information about the technology, people, organization, processes, risks, progress, schedule and financial support. The review panel was asked for their comments, suggestions and an overall assessment of the feasibility and likelihood of success of the Fox-1 project.

- What were the qualifications of the feasibility review committee members?

The feasibility review panel included the following members (alphabetical order):

1. Mr. David Hinkley is the Project Leader, Mechanics Research Office of The Aerospace Corporation.
2. Dr. Allen Katz is a Professor of Engineering Science, College of New Jersey and President of Linearizer Technology, Inc. (LTI.)
3. Mr. Jan King is a distinguished space industry veteran with more than 40 years of experience including the development of 12 large and 17 small spacecraft and one launch vehicle.
4. Dr. Robert McGwier is the Director of Research, Hume Center for National Security and Technology and a Research Professor, Department of Electrical and Computer Engineering, Virginia Tech.

Please see APPENDIX 1 for resumes of the members of the review panel.

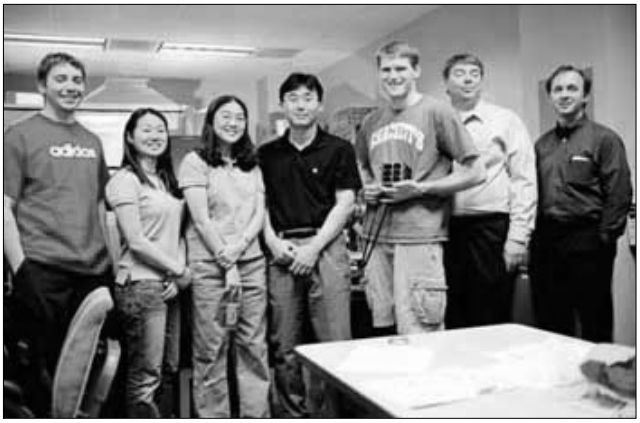
- What factors did the feasibility review use to assess feasibility?

The review panel assessed the Fox-1 project according to the following factors:

5. Technology and technical approach
6. Engineering process
7. People and project organization
8. Major risks and mitigation
9. Progress to date
10. Remaining development and schedule
11. Project financial requirements and support

- How were the management team roles, experience, expertise, and the organizational structure of the team assessed?

The reviewers noted that the tremendous depth and breadth of experience on the Fox-1 team far exceeds that of a typical CubeSat project. They also noted that although the all-volunteer staff was identified as the major project schedule risk, AMSAT has been doing satellite development this way for 40 years and has never missed a launch.



- How was the technical development risk associated with the overall CubeSat mission assessed?

The review panel was satisfied that we had addressed the major risks but suggested that we were probably being overly conservative in our space radiation concerns. Another review panel member offered to help by providing assistance in testing components.

- If the CubeSat investigation requires critical technology development for flight readiness, how were the areas assessed, and how were the plans for completing technology development assessed?

Fox-1 does not depend on any critical technology development for flight readiness.

- Concerning the development of the CubeSat for flight, how was the probability of success assessed?

The review panel assessment was that the project has a very high probability of success. They noted that AMSAT has an excellent record of accomplishment and that the people working on the team have substantial experience.

- What was the outcome of the feasibility review?

The review panel, while noting the high probability of success, offered a few suggestions for improvement. A key suggestion was to move our Critical Design Review to August 2012. This would allow the developers to address any problems found on the engineering prototype prior to construction of the flight models.

- How did Respondent respond to and/or address the findings of the feasibility review?

This proposal as submitted reflects all of the improvements suggested by the review panel.

- Is there sufficient financial support for the development of the CubeSat payload and for all other costs incurred by Respondent to support its participation in the project?

AMSAT has committed to fully funding the Fox-1 project. A letter of financial support from the AMSAT treasurer is included in APPENDIX 2.

Summary

In the ELaNa announcement, NASA indicated that they expected to complete the project selection process on January 30, 2012 and notify the selected projects. Since we have no experience with this process, it is impossible to predict the outcome. If Fox-1 is selected, AMSAT will be in a much better position to launch the satellite since we would save a substantial launch cost. Should Fox-1 not be selected for this round, we would most likely re-work our proposal and apply again next year. That could still allow a 2013 launch. In any case, the AMSAT team has put together an impressive proposal and the level of thought and detail provided should help in successfully completing the project and getting the satellite ready for launch.

References

[1] The NASA Strategic Plan can be found at: **http://www.nasa.gov/news/budget/**

[2] The NASA Education Strategic Coordination Framework can be found at: **http://www.nasa.gov/offices/education/performance/strategic_framework.html**

Apogee View - continued from page 3 ...

and coordinate an education initiative program and serve as AMSAT's senior point of contact with outside organizations regarding educational outreach. Given the increasing importance of fulfilling education goals as justification for launch opportunities, this is an increasingly important subject for AMSAT. Mark is aptly suited for this position as he is a professor of biology and the Dean of the College of Arts and Sciences at Campbell University, Buies Creek, NC and is very familiar with the potential for using the Amateur Radio satellites as a teaching resource and understands the teacher perspective as well.

Satellite Changes

The loss of AO-51 on November 29, 2011 is a major loss for Amateur Radio. A very popular satellite that provided outstanding service for seven years, AO-51 demonstrated the importance of having reliable satellite services that could be easily used by newcomers and old hands. The satellite's extensive capabilities were appreciated by those that took advantage of what the satellite had to offer both in terms of voice and packet services. Thanks to the extensive efforts of AMSAT's control operators who spent countless hours managing the satellite's resources, AO-51 continued to be available despite the fact that the satellite's batteries were failing. AMSAT VP-Operations Drew Glasbrenner, KO4MA, and his control team (including Mark Hammond, N8MH, Gould Smith, WA4SXM, Kevin Schuchmann, WA6FWF, and Mike Kingery, KE4AZN) are to be commended for the countless hours managing the spacecraft, uploading and reloading spacecraft software and doing what was necessary to keep the satellite 'afloat'.

Meanwhile, ARISSat-1's orbital decay is accelerating and it now looks as if that satellite will re-enter the atmosphere in January or February. ARISSat-1's popularity and technical achievement (despite the loss of the Orlan battery) is something that we're all proud of, but again the deorbited spacecraft will be viewed as a loss. If you haven't listened to the satellite or used its transponder, now is the time to take advantage of this satellite (in daylight only) before it is re-enters the atmosphere.

What's Next?

At the AMSAT Space Symposium a number of presentations were made regarding Fox-1, our latest satellite project. Fox will be a replacement for AO-51 from a ground station point-of-view, allowing two-way communication with an HT and Arrow-type hand held antenna. While the uplink will be on 70 cm and the downlink on 2 m (the opposite of AO-51), the experience of working a FM single-channel satellite will be similar to the ease of working AO-51.

On November 15, 2011, AMSAT submitted a grant application to NASA under the Educational Launch of NanoSat (ELaNA) program where NASA would assume the costs of launching Fox-1. We will know by January 30, 2012 whether NASA sees AMSAT's project as supporting their educational and strategic goals in a way that would justify providing a launch opportunity for Fox-1. Should our application be accepted, we could see Fox-1 placed in orbit in the 2013-2014 timeframe.

From a spacecraft development perspective, AMSAT does not have a great amount of time to develop a spacecraft prototype, a flight unit and a flight spare. We will be working hard in 2012 to meet whatever deadline NASA gives us to have our spacecraft available for their flight opportunity.

Fund-raising

By this time you should have received our letter to the AMSAT membership asking for financial support needed to get Fox-1 built. Typically, December is a month where donations are made to take advantage of end-of-year tax strategies. For those individuals over the age of 70.5 years, there may also be Required Minimum Distributions (RMDs) from IRAs that could also influence donation decisions. Please give generously to AMSAT so that we can once again have a FM satellite that meets user expectations and which will provide educational outreach opportunities. Details on Fox-1 may be found at: http://www.amsat.org/amsat-new/fox/

The New Year

AMSAT enters the new year having accomplished much in 2011 and focused to continue on achieving more in 2012. This includes:

- Development work on Fox-1
- Fund-raising for Fox-1
- Transition of *The AMSAT Journal* to a new publishing team under Doug Loughmiller, W5BL
- Enhance Education Outreach under the leadership of Mark Hammond, N8MH
- Build awareness/support for AMSAT, including reversing the declining membership trend
- Update our Web sites (www.amsat.org and www.arissat1.org)
- Continue to build the management team, finding volunteers to fill key needs

Best wishes this holiday season,

Barry A. Baines, WD4ASW

President

Dick Daniels - SK - continued from page 12 ...

Dick spent a lot of time working on the gantry level of many launch vehicles, installing AMSAT spacecraft on Delta and Ariane launchers and, as a NASA-HQ employee, he built more space flight hardware in his basement than anyone working for NASA in Washington, D.C. ever even saw in a lifetime. He loved life and he made his count. And he made a huge difference to the outcome of our hobby and our belief in what an individual can do in space.

So, we've lost someone that meant a lot to us all and someone who will be impossible to replace. History may repeat itself but, it will be a long time before someone like Dick Daniels, with his unique set of skills comes our way again. So, W4PUJ is SK. This is a sad day for Amateur Radio and to the small satellite space community and even more for those of us who loved him.

Dick, you made a difference and it will be a long time still before others reach where you have been. What you did wasn't just worthwhile – IT WAS FANTASTIC! I'll never forget our time working together! It was an amazing hobby, really! An amazing LIFE!

Jan A. King

W3GEY/VK4GEY

•–•–• –•– •••–•– ••

AO-51 End of Mission

by Drew Glasbrenner, KO4MA, AMSAT VP Operations

On November 29, 2011 AO-51 ceased operations due to battery failure. Launched on June 28, 2004 as AMSAT Echo and becoming AMSAT OSCAR 51, this satellite quickly established itself as the star of the AMSAT fleet. Based upon a SpaceQuest commercial small satellite design, which itself was derived from the original AMSAT microsats launched in 1991, AO-51 was a versatile spacecraft. Included onboard were two UHF FM transmitters, a 2.4 GHz FM transmitter, four VHF user receivers and a wideband, all mode receiver known as the SQRX.

The Operations team tried many different combinations of receivers and transmitters over the seven years AO-51 was in operation, including V/U, V/S, L/U, L/S, V/US, L/US FM voice, 10 m, 2 m, or 23 cm SSB/CW up and 70 cm or 13 cm FM down, and 9k6 and 38k4 bulletin board system (BBS) downlinks on both 70 cm and 13 cm. We also scheduled different periods dedicated to non-traditional use, including Jamboree On The Air (JOTA) and ARRL Kid's Day where the satellite was set aside for youth use, periods designated for QRP and SSTV only, College Nights for university radio clubs, Experimenter's Nights, and annual Straight Key Nights using the SSB uplink. We also conducted two downlink-only events for the 40th anniversary of Apollo 11, and the 50th anniversary of Sputnik, where special messages and slow scan images were sent, and reception reports earned special QSL cards or certificates. AO-51 was also used to assist other satellite programs around the world, by providing numerous digital signal and frequency combinations for their experimentation and satellite development.

The unique abilities of AO-51 were also used to conduct some interesting experiments. The passive magnetic stabilization system used in AO-51 included the ability to reverse the magnetic polarity and "flip" the spacecraft so that the downlink antennas favored the southern hemisphere. Interesting side effects were observed when this ability was finally exercised (see article by VK4HI and N8MH in *The AMSAT Journal*, Jan/Feb 2011), including a rapid increase in the satellite spin rate. The Received Signal Strength Indicator (RSSI) output from the SQRX was also used to map the RF environment globally, both at amateur and non-amateur frequencies (*The AMSAT Journal*; January/February 08). Further refinement of the use of CTCSS (PL) access was possible using revised code with the two decoders onboard AO-51, with the results being integrated into our new Fox satellite.

As the orbit of AO-51 slowly precessed from an approximate mid-day and mid-night passes to the current early morning and early afternoon passes, it passed through several periods of continuous illumination. During these periods where no eclipses of the spacecraft occurred, more power was produced, but also more heat was generated. The internal battery temperatures often approached 40 degrees C with the transmitters running higher outputs to consume some of the power, and occasionally well exceeded this temperature range when a software crash or other event reduced the power the transmitters consumed and radiated as RF. In the command team's opinion, the prolonged exposure to the high temperatures was likely the prime factor other than age in the eventual failure of the cells. An earlier *Journal* article by VK5HI and N8MH supports this statement (*The AMSAT Journal*, Jan/Feb 2011).

As the cells in the battery began to fail, the spacecraft became difficult to maintain. The latest housekeeping code that was uploaded from the ground to run the spacecraft would often cause the IHU to crash immediately upon execution. The basic housekeeping code that was stored onboard the satellite in ROM seemed much more stable, and by running only this code, we were able to continue repeater operations, although any telemetry storage, SQRX or CTCSS operation, or BBS functions were then unavailable.

Through much trial and error, a balance between transmitter load and temperature was struck, by varying the downlink transmitter's power. This allowed extended operations for four months (July-November 2011), in a stable configuration, with two of the six cells completely shorted. To our surprise, there was sufficient battery capacity to keep the transmitter on during eclipse periods.

Toward the end, as eclipses in the northern hemisphere increased, it was observed that the transmitter strength would taper off soon after entering eclipse, yet would ramp back up upon entering illumination. This was first observed by John Papay, K8YSE, by examining automated recordings made in his shack on the early morning passes. Mark Hammond, N8MH, and I verified this with live telemetry, observing that as the nominal ~8 volt battery voltage approached 4.6 volts, the transmitters would gradually taper off in power output. We can deduce that the onboard 4.6 volt regulator was failing as the input voltage dropped below the required levels. As the third cell began to fail short, the available voltage just was not enough to run the transmitters, yet the IHU we assume continued on the 3.3 volt supply.

When the transmitters began to power down while the satellite was still illuminated, we knew the end was near. However, we did try to blindly command on the S band downlink in the hopes it may still operate. Sadly, it did not. For the foreseeable future, the command team plans to attempt to revive the satellite on a regular basis. The expectation is that perhaps a cell will fail open at some point and we will be able to operate the satellite solely from the solar panels. However, unlike AO-7, this type of operation will require a restart and commanding of the IHU every time the satellite exits eclipse. Hopefully, if we discover at some point in time this is possible, we can implement an automated system to do so.

The loss of AO-51 is a heavy blow, but losing the star of the AMSAT fleet has happened before and will happen again. It is the nature of satellites that they fail eventually, and AMSAT has been extremely lucky in the continued operation of AO-7. Please support the Fox project with your time and donations, as well as the other fine international projects such as Kiwisat, FunCube and Phase-3E, so that we can continue to keep ham radio in space.

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January 3, 2012 – Ben, KC9ROI, captured signals from ARISSat-1 using his new HT and fed that signal into his laptop to record the audio. He's bundled up and braving the cold temperatures in the photo at left. Ben also used his laptop to track the satellite's path across the horizon. The satellite re-entered the atmosphere on Wednesday, January 4th. Ben was able to record some of the very last images sent before the satellite de-orbited. It is thought the impact was in the South Atlantic.

News of Ben receiving some of the last images from ARISSat-1 and braving the cold to do it gained the attention of several AMSAT members including Bruce, KK5DO. Bruce is AMSAT's Director of Contests and Awards. He sent a personalized "Satellite Communicators' Club Award" highlighting Ben's achievement. The award was presented to Ben by Greg, N9CHA, at the January 2012 PCARA club meeting (above right). See http://www.n9xh.org/ for more information. (Photos and text are credited to www.n9xh.org.)

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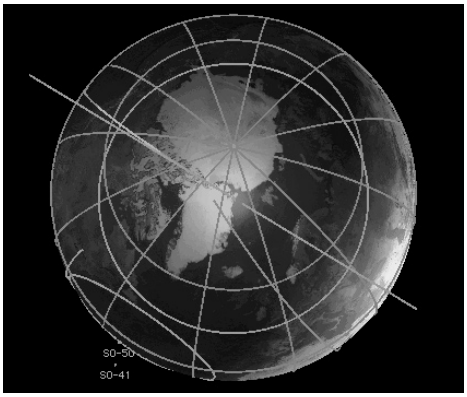

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- Educational activities
- Promoting AMSAT as an Area Coordinator

and any other area you think you think you can make a difference.

We often have people volunteer, but many don't deliver on their promises. So, pick an area that you think needs improvement and explain what you will do to make it better. Then do something to show that you can follow through.

Send your suggestions, actions plans and a description of why you are capable of doing this task to Gould Smith, WA4SXM, wa4sxm@amsat.org

AMSAT BoD Telecon Meeting, August 02, 2011

by Alan Biddle, WA4SCA, wa4sca@amsat.org

Called to order by President Barry Baines, WD4ASW at 2002 EST.

Attending:

Directors

Barry Baines, WD4ASW

Gould Smith, WA4SXM

Tom Clark, K3IO

Drew Glasbrenner, KO4MA

Lou McFadin, W5DID

Alan Biddle, WA4SCA

Tony Monteiro, AA2TX

Others:

Martha Saragovitz, Manager

Keith Baker, KB1SF, Treasurer

Bill Tynan, W3XO

The meeting was called to order by President Barry Baines at 2003 EDT.

The first item of discussion was the issue of whether an application should be made for an OSCAR number for ARISSat-1, and if so the correct procedure. It was constructed by a team from AMSAT-NA on behalf of the international ARISS organization; ARISS arranged for it to be launched and licensed as Russian spacecraft. Drew noted that the Russians have failed to complete the IARU coordination procedure. Coordination would normally be a prerequisite to the issuance of an OSCAR number. Tom suggested that the IARU Satellite Committee be polled for their concurrence that ARISSat-1 is to be issued an OSCAR number. This would normally be done by Bill Tynan, W3XO, but since Bill will be traveling, Barry will act on behalf of AMSAT-NA and the ARISSat-1 construction team.

Barry then brought up the approval of the minutes of the March 1, 2011 telecon formal board meeting. He requested that one paragraph be shortened to remove extraneous material. With this revision, approval of the minutes was moved by Gould, seconded by Lou and then passed unanimously. The minutes will be published in *The AMSAT Journal*.

Tony then reviewed the current status of the Fox Project. The original Engineering Task Force specified a baseline spacecraft with numerous options for additional capability. Several of these options such as deployable solar arrays and a SDX transponder had become part of the Fox Project. However, the impending failure of AO-51 and the need to have a replacement available as soon as possible mandates that the Fox Project be broken into two parts. Fox-1 will be a baseline satellite consistent with the original ETF report. This will use basic, robust components which can be ready for a launch in early 2013. The more advanced, optional capabilities from the ETF study will be deployed in the Fox-2 follow on.

Tom pointed out that AMSAT has had several gap filler satellites over the years in response to timing and needs. Oscar 6 served this purpose after Oscar 5, and in turn Oscar 8 did so after Oscar 7. Doing this is consistent with the past successful AMSAT policy. He also emphasized that this will give time for the development of a new, robust telemetry system to replace the inefficient AX-25 commonly used in CubeSats.

Barry asked about the impact on costs and development time using two spacecraft. Tony explained that Fox-1 and Fox-2 can be developed largely in parallel, with the early results from Fox-1 feeding into the final development of Fox-2. Due to the availability of volunteer labor, this will have little impact on research and development costs. It also provides time for the more challenging issues of power controllers and radiation effects to be resolved.

Changes to the NASA ELaNa (Educational Launch of Nanosatellites) program will make opportunities open to AMSAT directly in the near future. The current program provides for a decision in early 2012 for a 2013 launch. NASA wants a long queue of satellites to insure that all launch opportunities are fully utilized. There is a nominal $30k launch fee, but it is normally waved. Binghamton University will build an experiment we will fly. Tom commented that in the past having a firm launch date has served to focus efforts and expedite progress, though as Gould mentioned, it has not worked that way with ARISSat-1.

Barry asked for further clarification about hardware cost issues of two satellites. Tony replied that solar cells and the usual CubeSat custom frames are the only significant cost items. Tom moved that "The evolutionary changes proposed by Tony to the Fox Project be approved." This was seconded by Lou and unanimously approved by the board. During the subsequent discussion it was decided to publicize this revision through an ANS article after the ARISSat-1 deployment, and publishing the current CONOPS (Concept of Operations) in *The AMSAT Journal*. This will also help with ITAR compliance. Barry suggested including sections by the various project team leaders.

Lou finished with a brief summary of the AMSAT-UK Symposium. The AMSAT-DL P3E satellite is still making progress while a launch opportunity is being sought. Also, the QB50 project has the required documents to proceed.

There being no further business, it was moved by Alan, seconded by Lou and approved unanimously that the meeting adjourn at 2142 EDT.

ARISS-I Annual Meeting

by Dave Taylor, W8AAS, w8aas@amsat.org

I recently had the privilege of representing AMSAT-NA at the annual meeting of ARISS International, which was held October 28-29, 2011 in Houston, Texas. The meeting was attended by hams from around the world, featured briefings on current and future projects and had several high-profile visitors (and one surprise guest).

ARISS-I is the organization that manages Amateur Radio on the International Space Station (ARISS) program. It was formed in 1996 to satisfy NASA's request to have a single organization as the contact point for all Amateur Radio activities aboard ISS. ARISS-I is governed by 12 delegates representing Amateur Radio organizations from the various regions that participate in the International Space Station effort: United States, Russia, Japan, Europe and Canada. The United States has two delegates, one appointed by ARRL (Rosalie White, K1STO) and one by AMSAT-NA (your author). AMSAT-NA also appoints one of the two Canadian delegates. Many other volunteers assist by serving as officers and committee members, and hundreds of hams assist each year with worldwide operations. In the past year, hams in 21 countries (and 1 space station) conducted 108 contacts with students at 116 locations (schools and other groups). Two-thirds of the contacts were direct, with students using an Amateur Radio station set up at their site. The remaining third were conducted using one of the 11 ARISS telebridge stations around the world.

Photo 1: Meeting day 2, in the Space Center Houston Boardroom.

Of the many purposes for holding an annual meeting, perhaps the most valuable is meeting face-to-face with the other delegates. Although we hold a monthly teleconference to handle regular business, meeting in person allows a better chance to share opinions and form the relationships that help the group function. This was especially critical this year. Several new delegates had been appointed to ARISS-I since the last meeting and this was the first chance for everyone to meet in person. In addition, many of the key NASA personnel responsible for overseeing ARISS are new to the program. They were able to attend the meeting, learn more about ARISS and how it works and share with us their views of where the program is headed.

In all, about 30 people attended the meeting, two by teleconference. Delegates from Japan, Europe, Canada and the United States were joined by NASA personnel and hams from the United States, Italy, Malta, and Brazil. You can find a full list of attendees in the meeting minutes (URL listed at the end of this article).

The NASA Perspective

ARISS was welcomed to Houston by Susan White, who leads the Johnson Space Center (JSC) Education Office. Although she was present only at the opening, other NASA representatives participated in the entire two-day meeting. These were Cindy McArthur (head of the JSC Teaching from Space office), Trinesha Dixon (the Teaching from Space employee responsible for day-to-day coordination with ARISS), and Dr. Regina Blue (the new head of the ISS National Lab Education Project).

NASA is facing tight budgets, as is everyone, and therefore is working to make the best use of available resources. ARISS is a valuable program for NASA Education because it provides effective science, technology, engineering and math (STEM) education through an extensive pool of non-NASA resources -- the hams who volunteer their time, expertise, and enthusiasm. As such, we were told the future looks good for continued NASA support of Amateur Radio aboard ISS.

Operationally, the ISS crew enjoys ARISS. It doesn't take much of their time, but lets them provide good education to, and have welcome contact with, school kids on Earth. Also, as we know, a few crew members really enjoy using their free time to make random contacts with hams. One such astronaut heard about our meeting and took the initiative to drop by for a visit. Mike Fincke, KE5AIT, dug out his ARISS shirt and spent part of the Friday lunch break visiting with us.

International and Committee Reports

ARISS practice is to circulate the regional and committee reports for review prior to the meeting, so that our meeting time can focus on questions and important issues. Accordingly, delegates covered only highlights of their region's activities. (The complete reports are available online; see the references listed at the end of this article.) All delegates present praised the support given to ARISS by their volunteers and partner organizations.

Europe, Japan and Russia have had an increase in numbers of contacts in the past year, with strong support in Europe from Paolo Nespoli during his ISS mission. The Canadian operations team continues to work hard providing contacts throughout Canada, including the far north, and is preparing for expanded activity during the coming mission by Canadian astronaut Chris Hadfield.

The United States team has developed and implemented a new school selection process. In addition to simply inspiring students, the new process will strengthen the role of education in ARISS contacts by engaging students in hands-on STEM activities. More about this later.

Photo 2: Mike Fincke, KE5AIT (right) and ARISS Chair Gaston Bertels, ON4WF.

Following the regional reports, we heard reports from the various ARISS committees. These committees comprise both delegates and volunteers from the ham community. We heard from the Educational Outreach/School Selection, Operations, Hardware and Project Selection and Use committees. The chairs of these committees reported on recent activities and changes in their membership. I've incorporated highlights of their reports in the other sections of this article.

Photo 3: ESA Astronaut Paolo Nespoli, IZØJPA, Presenting Details of the MagISStra Mission.

Changes and Partnerships in Education

Education was an important part of the early ARISS program. This importance has grown over the years to the point that it is now central to the existence of ARISS.

Dr. Regina Blue, new head of the ISS National Lab Education Project (NLEP), described how her group will be working to expand educational outreach on ISS. Overall, scientific and educational activities in the U.S. segment are managed by the Center for the Advancement of Science in Space (CASIS), a non-profit entity selected by NASA. For its part, NLEP will be soliciting proposals from academia, corporations and non-profit education groups. Dr. Blue expects ARISS to continue as a pre-existing part of NLEP activities aboard ISS.

NLEP works closely with the Teaching from Space (TFS) office, which manages the educational activities associated with ARISS contacts. Cindy McArthur, the TFS lead, explained that the new selection process for U.S. schools has two primary goals:

- to make the ARISS selection process more competitive and remove any need for organizations to have a pre-existing relationship with Amateur Radio.
- to put the burden on educators to develop an excellent and comprehensive education proposal, making the educational outcome of ARISS contacts even better than it has been.

The new process is used only for U.S. contacts currently, but Cindy plans to share it with the education offices of the other space agencies. It is hoped they might choose to adopt it as well someday.

The details of the new process were presented by Trinesha Dixon, who has responsibility in the TFS office for managing ARISS and the selection process. The basic details of the new process are:

- Schools and other groups (such as museums or Scout troops) contact the TFS office for proposal information and an ARISS planning guide.
- Interested educators submit a proposal outlining a detailed education plan that incorporates an ARISS contact.
- Proposals are accepted twice yearly for contacts to be scheduled during a specific six-month period.

Proposals are evaluated by a joint TFS/ARISS team against predefined criteria and the best ones are selected for a contact. The number of selected proposals is based on the number of anticipated slots in each period.

The decision to seek a direct or telebridge contact is not made until after the proposal has been selected.

The first proposal window was mid-May to mid-July 2011, for contacts in the first half of 2012. Fifteen U.S. groups were selected.

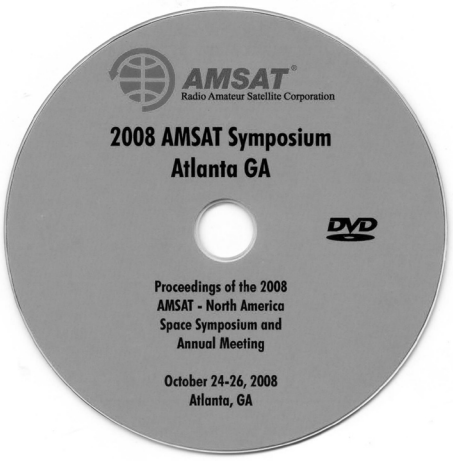
Photo 4: Group Photo with the Shuttle Full Fuselage Trainer.

The next proposal window runs November 14 to January 31, 2012, for contacts in the second half of 2012.

During his recent ISS mission, Paolo Nespoli, IZØJPA, participated in a unique educational alliance between AMSAT-Italia and the Italian Space Agency (ASI). On Saturday, he joined us to give a very enthusiastic presentation about this project, called MagISStra. AMSAT-Italia formed six ham teams to handle the contacts, and mentors worked with teachers on lessons for the students. ASI produced 3D satellite puzzles, space science booklets, and other educational tools. Aboard ISS, Paolo talked to a record number of schools (45) and performed a number of double contacts, returning on the next orbit (on his own initiative) to extend the contact time. AMSAT-Italia used an innovative "hot backup" combination of direct and telebridge operation for these contacts.

Current and Future Hardware: Improved Radios and HamTV

The current hardware on ISS is a mix of the ARISS Phase One and Phase Two systems. The Russian Zvezda Module (sometimes called the Service Module or SM) holds the Phase Two equipment: four ARISS



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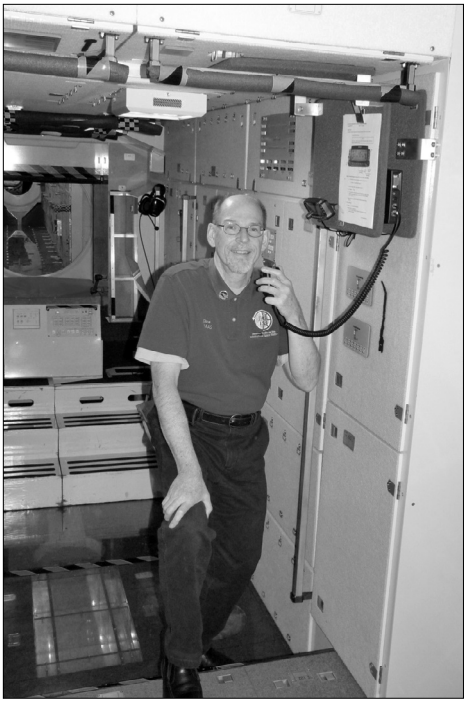

Photo 5: The Author at the ARISS D700 Training Radio.

antennas and a Kenwood D700 transceiver. This radio is used for school contacts and has in the past been left in digipeater mode (and occasionally cross-band voice repeater mode) when unattended. Unfortunately, we expect the Russians will keep this radio turned off most of the time in the future, to extend the radio life. Zvezda also holds the VC-H1 SSTV unit, which sees limited use because of its reliance on batteries.

The European Columbus Module has a new amateur VHF/UHF antenna and is home to the old Phase One Ericsson hand-helds and packet module. The VHF Ericsson did not work well this past year when retrieved from storage and used for school contacts. It has been set aside. The UHF Ericsson is currently operational using the packet module to digipeat on 437.55 MHz with a callsign of RS0ISS (unproto path ARISS). Plans are underway to fly a replacement VHF Ericsson radio. If this is successful, school contacts will move to the Columbus Module. ARISS also is working on getting a new Kenwood D710 modified and approved for flight; this will go into the Columbus Module for voice contacts and possible cross-band repeater use.

An important topic at the delegates meeting was the current work by ESA and AMSAT-Italia to develop a digital amateur television system (HamTV). This system will provide downlink-only video at about 2.4 GHz using the L/S band patch antennas mounted on Columbus. Plans call for using the HamTV system in conjunction with school contacts to give the students live video of the crew member talking with them. Technical aspects of the HamTV project were presented by European delegate Emanuele D'Andria, I0ELE, at a session Thursday night (before the formal meeting). After further discussions during the Saturday session, the delegates voted to approve the project and encourage AMSAT-Italia to move forward.

There was a brief discussion of power converters to be used for current and future amateur radio equipment. These are needed to convert ISS power to the voltages needed by HamTV, the Ericsson and Kenwood radios, and the SSTV unit. It will be important to allow both HamTV and a VHF transceiver to operate simultaneously from a single ISS power port.

An update on ARISSat-1 operations and education efforts was given to the delegates and NASA attendees. Much of this information has been covered extensively in *The AMSAT Journal* and at the AMSAT Symposium, so I won't repeat it here. Overall, education efforts have fallen short of anticipated levels and the need for more educational work in the future was recognized. However, reactions were generally favorable and appreciative of what has been accomplished.

Miscellaneous Issues

Privacy concerns have become an issue in ARISS activities. Gaston Bertels, ON4WF, drafted a release form that can be used in European countries to cover the use of names and contact information for ARISS purposes. In the United States, privacy laws are more of a problem and the U.S. team is working with NASA to find an acceptable method of handling the personal information we obtain.

Another issue that came up is frequency coordination. While researching frequencies for HamTV, the AMSAT-Italia team discovered a possible requirement to register frequencies with the International Telecommunications Union. After discussion, it was decided that ARISS will be looking into this issue.

All Work and No Play?

Despite the long meetings, it wasn't all work. On Friday afternoon, NASA treated us to an inside tour of JSC. We visited the Apollo Mission Control Center (a National Historic Landmark) and were able to wander among the consoles and sit in the Flight Director's chair. We then visited the ISS Mission Operations Center and the Space Vehicle Mockup Facility (a typically pedestrian NASA name for a spaceflight wonderland). This building houses a full-size mockup of the ISS, a full-size shuttle trainer, and many smaller trainers for past and future spacecraft. Of particular note, we were allowed inside a shuttle crew compartment trainer and the Zvezda Module mockup, where crew members train to use the Kenwood D700 for school contacts. It was surprising to see just how cramped the shuttle actually was; much less roomy than it looked in videos. Next, quick stops at the Saturn V rocket and the new home of the JSC club station, W5RRR. The day ended with a Texas barbeque at the home of NASA TFS lead Cindy McArthur and her husband, astronaut Bill McArthur, KC5ACR.

Acknowledgements

The ARISS delegates, and I personally, would like to thank all those who made this valuable meeting so successful. This includes the primary planners--Carol Jackson, KB3LKI, Trinesha Dixon (NASA), and Nick Lance, KC5KBO--and the team of hams who volunteered to help with transportation.

References

Information about ARISS and how to submit a contact proposal is available at **www.ariss.org**

Minutes from this and previous meetings are available at **ariss.rac.ca/arissmin.htm**

Reports and presentations from the meeting are posted online at **www.amsat.org/amsat/ariss/Meetings/2011_Houston/Presentations/**

SSTV Pictures via the ARISSat-1 RADIOSKAF-V KEDR Transponder

by Farrell Winder, W8ZCF, fwinder@fuse.net

The ARISSat-1 RADIOSKAF-V KEDR satellite was hand launched from the ISS by Sergei Volkov, RU3DIS, and Alexander Samokutyaev on August 3, 2011 and re-entered the Earth's atmosphere on January 4, 2012. It went down in the Atlantic Ocean west of Angola.

The transponder section of this satellite provided a very challenging, exciting and educational experience during its life in orbit. Three stations, as discussed in this paper, have reported sending and having pictures received via the transponder. However, many CW/Voice contacts were reported.

A Challenge was Introduced

While the 2 m section of the satellite provided easy copy of on board recordings of FM Voice, SSTV [1] and Telemetry, this was not the case when trying to receive signals from the transponder. Just prior to launch of the satellite during their EVA, the Cosmonauts reported that the 70 cm antenna was missing. It apparently was inadvertently broken off. After discussion and a lengthy delay, it was decided to go ahead and launch with the missing antenna. It is estimated by Lou McFadin, W5DID, ARISS Engineering Hardware Manager, that there were about 1.5 inches of RF sensitive length remaining inside the Delrin (nonconductive) support base. This length calculates to about 1/16 wavelength that was capable of receiving incoming transmissions. The greatest challenge was therefore presented in getting a signal from Earth to the remainder of the 70 cm antenna on the satellite.

Many attempts were made from my station trying to contact voice and CW signals, which were heard very weakly. Many replies made to identifiable signals did result in 2 confirmed contacts, one to Robert Atkinson, K9OIM, Almo, KY and one to Peter Portanova, WB2OQQ, Massapequa, NY.

Success of SSTV Pictures

On August 9, 2011 Henk Hamoen, PA3GUO, in the Netherlands sent an SSTV picture of his call sign through the transponder and received back a copy at his station. (See Photo 1.) This gave me a great incentive to also try SSTV. My son, Jeff Winder, KB8VCO, and I spent time at NASA Houston working on SuitSat-1 and were very interested in this reconfigured satellite. We teamed together on November 12, 2011 to manage all the variables and succeeded in sending and receiving an image of my automobile license plate through the transponder. (See Photo 2).

My setup used two computers with MMSSTV software, one to transmit, the other to receive. The antennas used were an M Squared 2MCP14 for 2 m and a stacked pair of K1FO antennas for 70 cm. The antennas were manually controlled, closely following the changing azimuth presentation from Nova for Windows. Two Yaesu 736's were used, one to transmit and one to receive.

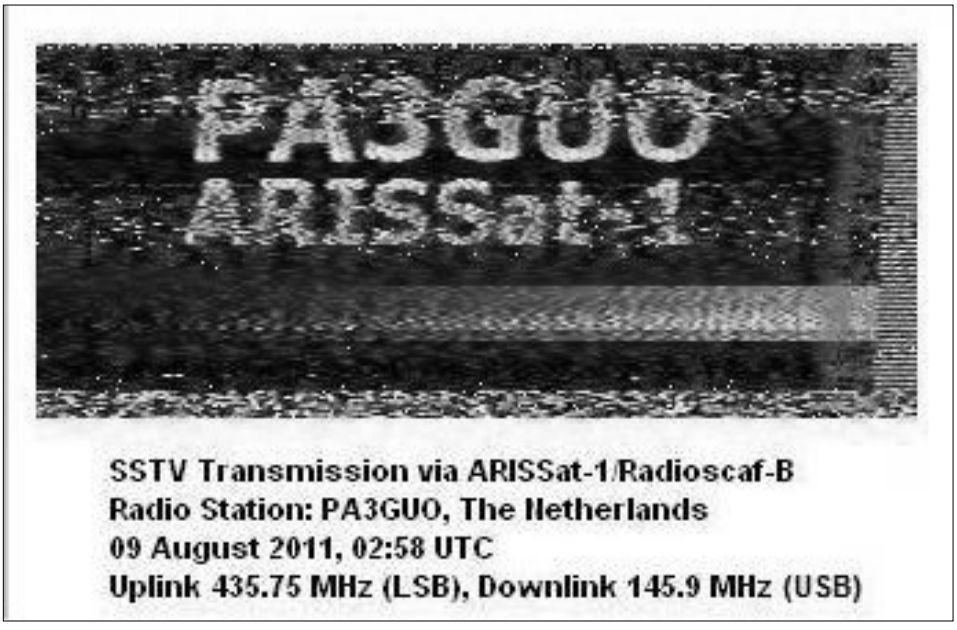

Photo 1: TX and RX by Henk Hamoen, PA3GUO, The Netherlands.

The beginning 70 cm transmitter frequency setting was 435.750 MHz LSB. Power out to the antenna on SSB voice ranged 20-100 watts peak with a higher average on SSTV. The 2 m receiver was fixed at 145.930 MHz USB.

Managing Doppler

Doppler control was a very difficult factor with the small signal return. After many tries, a technique was devised to locate the correct signal frequency return which would place the sync for the R36 format at the proper place on the MMSSTV spectrogram to initiate the start of the received image. This was done by first transmitting the 1750 Hz signal in the MMSSTV program and receiving its return, adjusting the transmitter frequency to center it as close as possible to the 1750 position as depicted on the MMSSTV spectrogram. Once located the SSTV picture was immediately started. The resulting R 36 sync pulse appearing at 1200 Hz was then used as the primary "beacon" for Doppler control. This was still difficult as the returning sync pulse often became embedded in noise and Doppler adjustment was lost. It was very evident that the effective receive position of the shortened 70 cm antenna on the satellite had to be aligned as nearly perfect as possible with the transmitting antenna on Earth. QSB on the return signal indicated that there was possibly some tumble or spin of the satellite and therefore the sensitive position of the receive antenna was not always in view which made its position critical to receive an R36 picture (36 seconds duration).

Two More Successful Pictures

Additional SSTV transmissions from my station in December resulted in pictures being received, one at my location and one by Doug Papay, KD8CAO, Zeeland, Michigan. (See Photo 3.) As may be noted, KD8CAO's picture was the best of those received. He had a special cavity filter which I believe enhanced his S/N ratio. Two other stations received fairly good parts of the transmitted pictures of my call sign. These are Burns Fisher, W2BFJ, Brookline, NH and Jerry Pixton, W6IHG, Strasburg, VA. Complete pictures were not possible probably due to my inability to correct Doppler of my transmissions along with further correction of Doppler at remote receiving locations. Paul Williamson, KB5MU's 'One Rule

Photo 2: TX and RX by W8ZCF / KB8VCO, Cincinnati, OH. November 12, 2011, 19:08 GMT.

for Doppler Tuning' was used by changing only the 70 cm transmitter frequency at my station.

A third station, Roland Zurmely, PY4ZBZ, Minas Gerais, Brazil sent an image via the transponder on December 12, 2011. He received back a Pic Fall transmission using an SDR-IQ (SDR Software Defined Radio with Spectrum Analyzer and Panoramic Adapter). (See Photo 4.) It is remarkable that he used only 18 watts into a 6 element UHF Yagi. PY4ZBZ is also to be noted for his excellent Web page: (**http://www.qsl.net/py4zbz/arissat.htm**) of ARISSat-1 covering its performance while in space. He is also to be recognized for his development of SSTV software, DIGTRAX.

A Bit of DX

DX was not, in my endeavors, a goal through the transponder. However, on January 3, 2012 at 18:16 UTC , Kerry LaDuke, WC7V, in Livingston, MT reported receiving my CW call sign from Cincinnati, Ohio. The distance between us is 2261 km (1405 miles). On December 18, 2011 Hank Cantrell , W4HTB, Bowling Green, KY, 182 miles, reported receiving my signal, and I heard a signal, but a two-way contact was not verified. On one try, W4HTB was able to transmit and hear his own call.

Recognition of Success of Satellite

Much recognition must be given for the success of this satellite to Lou McFadin, W5DID, ARISS Hardware Engineering Manager and his Team. This would include Steve Bible, N7HPR, and his Engineering group at Microchip Technology Inc. in Arizona. Great thanks also to Sergey Samburov, RV3DR, Chief of Cosmonaut Amateur Radio Department, Korolev, Russia for his original concept of SuitSat-1 and the testing of ARISSAT-1 RADIOSKAF-V KEDR. Also thanks to Valery Pikkiev, UA3WBV, and his group at KURSK University for the on board Science Experiment equipment to measure the vacuum of space.

AMSAT is also to be commended for the many articles, specifications and updates of progress of this satellite over some 4+ years of engineering and development. Tony Monteiro, AA2TX, Vice President of the AMSAT Engineering Group and his team are to be recognized for implementing the first successful use of SDX (Software Defined Transponder) in an Amateur Radio satellite.

We trust that AMSAT, ARISS and RSC-Energia, Russia will be able to develop and launch other similar satellites in the near future.

References

[1] See: **www.amsat.org/amsat/ariss/SSTV** and **www.ariss-sstv.blogspot.com** for many of the excellent Earth Pictures taken by the on board 4 cameras and also the stored pictures which were transmitted via the 2 meter FM down-link section of this satellite.

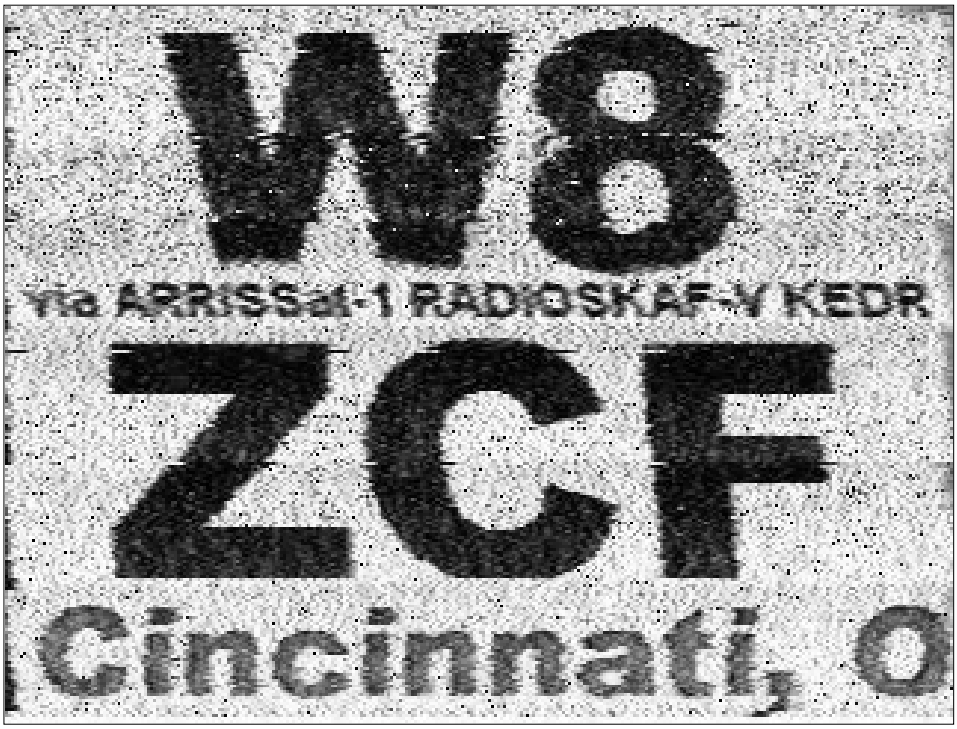

Photo 3: TX by W8ZCF. RX by Doug Papay, KD8CAO, Zeeland, MI.

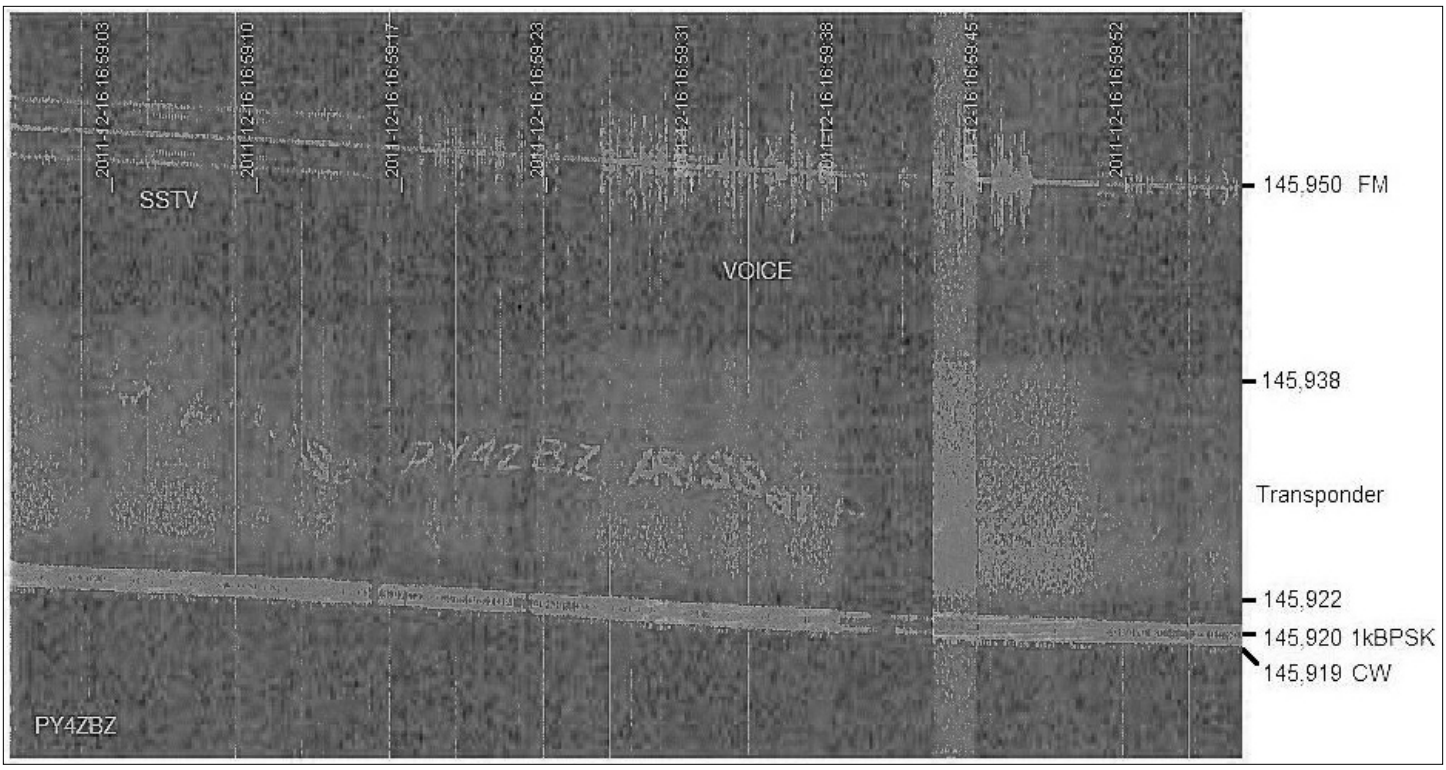

Photo 4: TX and RX by Roland Zurmely, PY4ZBZ, Mineas Geraios, Brazil.

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IC-9100

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100/100/100/75/10[1] Watt Output[2]

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Independent Receivers

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